KNOWLEDGE

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V VOICE

The boy on the left has his finger on his Adam's apple, or larynx. On the right is a sectional view of the head and neck, showing the upper respiratory passage

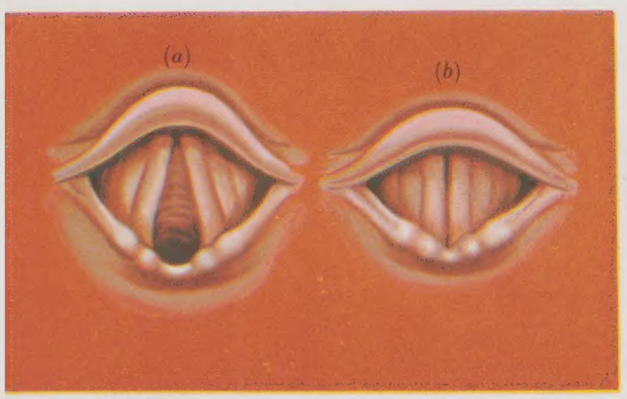
gɒd seɪv ˈəʊə greɪʃəs kwiːn
hɒŋ lɪv ˈəʊə nəʊbl kwiːn
gɒd seɪv ðə kwiːn
send hɜ vɪkˈtərɪəs
hæpɪ ænd ˈglərɪəs
hɒŋ tu reɪn ˈəʊvə ʌs
gɒd seɪv ðə kwiːn

No; this article is not to be written in an obscure foreign language. This 'verse' is simply the first stanza of *God Save the Queen* written in International Phonetic Script. Each symbol of the script stands for a sound made by the human voice during speech, and by using the symbols in groups it is possible to 'write' the sound of any word almost exactly. Exact and reproducible voice sounds, which convey elaborate *thoughts*, are very much a human accomplishment, for, though many animals too have voices, they use them merely for rather crude expressions of their *feelings*.

The human voice is undoubtedly one of the great features of Man's evolution; and it is also one of the most complex. Speech involves the lungs, the windpipe, the voice-box, the throat, the palate, the nose, the tongue, the lips, and the teeth. In addition a large part of the brain is required for the control of the muscles of these organs.

If you place a finger at the front of your throat about an inch below the chin, you will feel a small bulge of rather irregular shape. Swallow, and it will move sharply upwards and then return less rapidly to its original position. This bulge is called the 'Adam's apple', for it is said to represent a lump of apple which stuck in Adam's throat when he ate the fruit of the Forbidden Tree. Of course this is only a legend, but in a way it is quite a good one, for, if you look carefully, you will notice that the bulge is much larger in men than it is in either women or children. Anatomists, who are naturally more interested in anatomy than legends, have studied the 'Adam's apple' very carefully, and their name for it is the *larynx*. They know it as the organ in which many of the voice sounds are made, and it is for this reason that, in everyday speech, the larynx is often called the 'voice-box'.

The vocal cords seen from above: (a) drawn apart, and (b) close to each other



The larynx

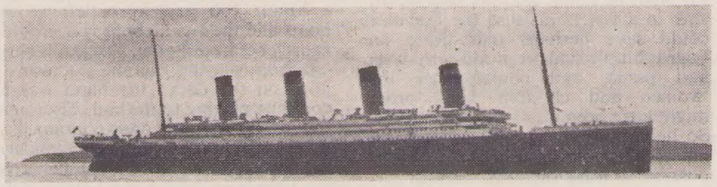
The larynx is placed at the upper end of the windpipe, or *trachea*. It is a little tube made of cartilage and lined on the inside with mucous membrane. The lower end of the tube opens into the top of the trachea, and the upper end leads into the throat or *pharynx*. This arrangement allows the breath to pass easily from the mouth, the nose, and the pharynx, through the larynx, and down the trachea to the lungs. Unfortunately, an airway as simple as this would allow food to take the same route, and so, to prevent such a disaster, the upper end of the larynx is provided with a little flap called the *epiglottis*. When we swallow, the epiglottis folds across the laryngeal opening, and by so doing closes the entrance. In this way the food is effectively kept out of the larynx and passes instead into the gullet, or *oesophagus*, which lies just behind.

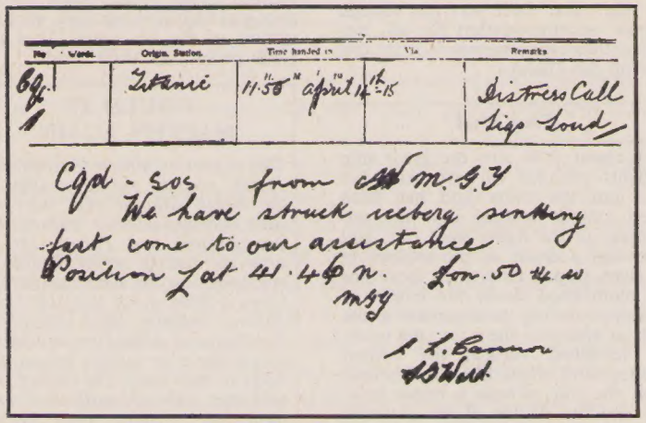
Inside the larynx are the *vocal cords*. These are two thin sheets of tissue which project horizontally into the cavity of the larynx from the side walls. At the back each cord is attached to one corner of a small triangular cartilage, the *arytenoid cartilage*. To the other end of each cartilage are joined a number of tiny muscles. The contractions of these muscles control the positions of the arytenoid cartilages and, through the cartilages,

Previous page: Regimental Sergeant-major Brittain of the Coldstream Guards, famous for his powerful voice, exercises his vocal cords.

KNOWLEDGE NEWS

Week beginning 18th August 1963

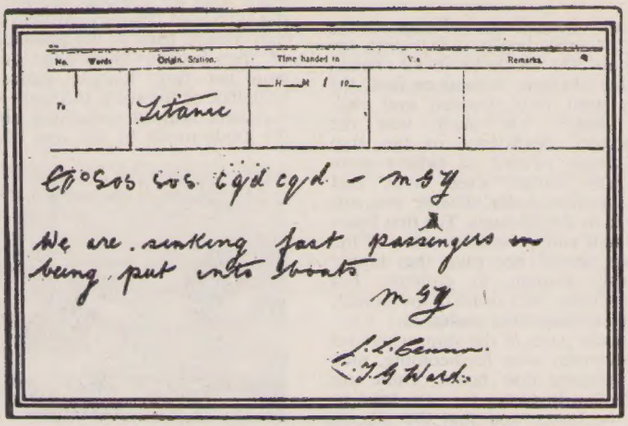
THE  SHIP 'THAT COULD NOT SINK'



No.	Words	Origin. Station.	Time handed in	Via	Remarks
6Q 1		Titanic	11.55" April 14th-15		Distress Call Sigs Loud

Cqd - SOS from M.G.Y
We have struck iceberg sinking fast come to our assistance
Position Lat 41.46 N. Lon. 50 14 W
M.G.Y
J. L. Cannon
Asst Wtd

The message received by the 'Birma' five minutes after the 'Titanic' had struck the iceberg



No.	Words	Origin. Station.	Time handed in	Via	Remarks
		Titanic			

Cp SOS SOS Cqd Cqd - M G Y
We are sinking fast passengers are being put into boats
M G Y
J. L. Cannon
T. G. Ward.

The last desperate message from the 'Titanic'

One of the posters of an evening paper which at lunchtime gave London the almost unbelievable news of the 'Titanic' disaster

'God Himself could not sink her', the people of the time said of the *Titanic*. But on a beautiful, starry night this great ship, the largest in the world, hit an iceberg while travelling at full speed. The unbelievable had happened; the *Titanic* was mortally wounded. About two hours later she sank. It caused one of the greatest sensations of this century, and rudely shattered the supreme self-confidence of the pre-war era. Today around the name of Titanic there is still an aura of horror and mystery.

IT was nearly midnight. Some of the passengers were already in bed. Others were playing cards or chatting over coffee in the luxurious lounges of the most luxurious ship afloat.

A few passengers had been aware of an increase in the throbbing of the ship's engines, as if the speed had been increased. A little later most people noticed that the ship gave a kind of heave which in some parts of the ship was felt as a distinct jolt. But no one was worried by this; not even when the engines suddenly stopped. Certainly it was unexpected for a huge liner, ploughing its way from Southampton to New York, suddenly to stop without warning in the middle of a freezing night hundreds of miles from its destination; but then confidence was restored when the engines started again, although admittedly at a much reduced rate. Few of the crew and none of the passengers were aware that the beautiful *Titanic*, the largest ship the world had ever seen, had been ripped apart by an iceberg and water was pouring in, flooding the compartments of her starboard side. In fact, what had happened was almost unbelievable. The jagged edge of the iceberg had ripped open six of the *Titanic's* watertight compartments. With only two or possibly three or four of these compartments flooded, the *Titanic* could still have stayed afloat. In fact, if she had hit the iceberg head on, the great disaster would most probably never have occurred.

News of the *Titanic's* fatal injury was brought to the captain, E. J. Smith; even he, familiar as he was with the ship's structure, must have found the full extent of the disaster difficult to believe.

The passengers had as yet no idea that anything serious was wrong. The heave, the stop, the start, and then another stop brought many of them on deck to find out what had happened. Someone discovered that one of the forward decks was covered with pieces of ice and snow dislodged from the vanished iceberg. Some of the passengers even arranged a snowball match for the following morning. But no one was worried – the *Titanic*, they were sure, was unsinkable. She was like an immense lifeboat. It therefore came as a surprise when the order came for everyone to come on deck with his, or her, lifebelt. There was no alarm, for standing on the top deck 75 feet above the water, which was as calm as glass and as smooth as oil, the great ship felt as steady and impregnable as an island. Some were unnerved when the steam from the boiler rooms was let off. It sounded like a thousand locomotives crashing through a tunnel, and conversation was impossible except at the top of one's voice, through cupped hands. But after all, people thought, trains at a station let off steam, so why should not a ship at rest in mid-Atlantic do so.

[*continued on page 2*

Captain E. J. Smith of the 'Titanic' with the purser. Both men were drowned with the ship, as were all the officers save one

ILL-OMENS

There were several ill-omens for the *Titanic's* maiden voyage. As the ship left Southampton Water she almost collided with a smaller liner, the *New York*; another bad omen was the stoker who appeared at the top of the fourth funnel for a joke, just as the ship was docked in Queenstown, the last call she ever made.

'TITANIC'
continued

Few guessed the real reason for letting off steam: that there would be a colossal explosion if the boilers were at high pressure when the ship sank. Few also had yet an inkling that there was anything slightly wrong, let alone gravely wrong. Then, as if to dispel these happy illusions, there was a 'whoosh' from the bows and a shaft of light hurtled into the air; up and up it soared to hundreds of feet, and then burst in a shower of brilliant stars. Every passenger mouthed the one word 'rockets' – everyone knew what rockets at sea meant. In this case, it meant that the largest ship in the world was signalling for help from anyone near enough to see.

Boats half empty

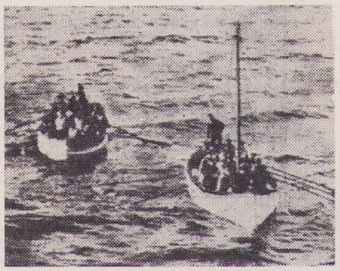
It was now about half-past twelve and the crew began unfastening the lifeboats. On all decks in all classes, whether steerage, second or first, the order went out: 'women and children only'. Yet such was the passengers' confidence in the ship that many refused to believe there was any danger even now, and that the 'unsinkable' *Titanic* was not safer than the lifeboats. The first boats went half empty because many of the women would not take the danger seriously enough to embark; but other women, well aware of the danger, refused to leave their husbands.

In some parts of the ship, where no more women were forthcoming, men were allowed into boats. There are stories that in places the men tried to rush the boats, and that the officers were forced to keep them back with revolvers; but if revolvers appeared once or twice, there was certainly no panic, and everyone remained calm to the end.

Later, some said that it was scandalous that the boats should leave only half full – but that night Captain E. J. Smith was faced with the most terrible of decisions. He could say what he knew: that the ship would sink in a few hours and the lifeboats could save perhaps half those on board; but this might produce hysteria and panic, and consequently the 'women and children only' order might have been impossible to enforce. So he compromised, and ordered his officers to try to persuade as many as possible to leave the ship.

Sinking beauty

It was difficult for those in the lifeboats, as they rowed away from the *Titanic*, to imagine that her end was so near. As they pulled away in the calm night with no icebergs in sight, only the bitter cold causing them discomfort, they looked back at the peaceful bulk of the *Titanic*, beautifully outlined with her four funnels against the brilliance of the stars. But some of the survivors noticed something sinister: the angle made by the line of portholes with the water. Some of the portholes near the bow were submerged, while those in the stern had already risen higher than they should have been.



Survivors from the 'Titanic' arriving alongside the 'Carpathia' in lifeboats

Last boats away

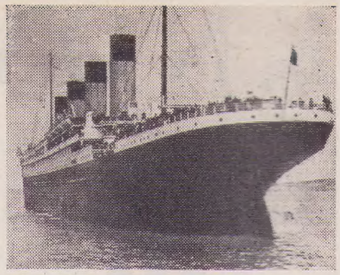
About 700 passengers left in the boats and the last lifeboat was lowered shortly before 2.20 a m. The ship's band had been playing ragtime for over an hour on the deck – the band was to continue playing to the end. Elsewhere in the ship staff and crew continued to do their duty. The engineers remained below, keeping the brilliant lights of the *Titanic* on until its final plunge into the sea.

And how did the captain, chief officer, and first officer of the greatest ship afloat feel at this time? No one will ever know, because they went down with the ship.

Few in the lifeboats realised the drama that was being enacted aboard the ship – that there was not enough lifeboat accommodation for all, nor indeed that everyone was not by this time off the *Titanic*.

The end

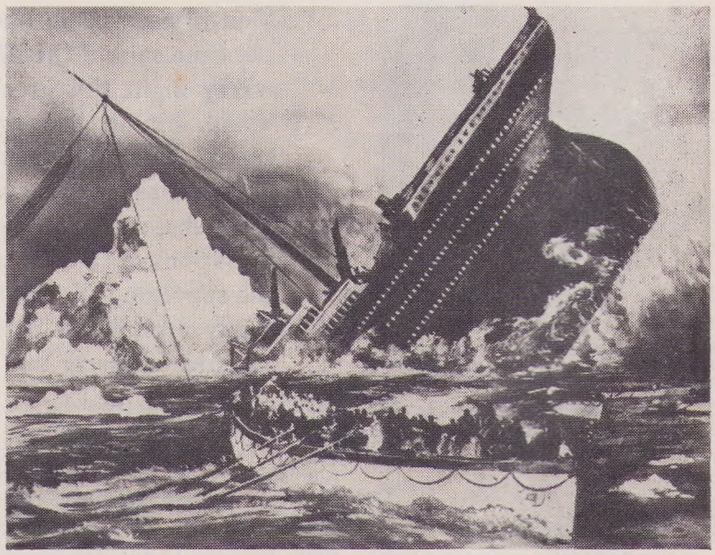
At about 2.20 a m the great ship suddenly plunged forward with her nose into the water and her stern raised almost vertical into the air. At once all the lights went out, and there was a crash as the engines in the stern ripped from their positions and plummeted down the length of the ship, crushing the engineers in the holds or sweeping them into the bows. She remained vertical for several minutes, and then, like an Olympic diver, she slid without a ripple bow-first into the depths of the Atlantic Ocean. And to the horrified ears of those in the boats came the sickening, heart-rending wail as 1,500 souls plunged into the icy grip of those frozen waters. For some minutes the agonised groans and cries for help continued. But many of those who had escaped being pulled down with the ship, and had come up alive, were soon victims of the icy water. That night 1,490 people lost their lives.



The 'Titanic' leaving Queenstown harbour on her ill-fated journey. The 'Titanic' was 883 feet long, 92½ feet broad; her height from keel to bridge was 104 feet. She had 29 boilers and 159 furnaces. The diameter of her funnels was 24½ feet. The crew numbered 860.

COULD IT HAPPEN AGAIN?

The answer is almost certainly no. Radar, used by the great ships on the North Atlantic run, rules out their collision with an iceberg. The International Ice Patrol, set up after the sinking of the Titanic, *is constantly on the look out for icebergs drifting down into the North Atlantic shipping lanes. Today the Ice Patrol is helped by aeroplanes which direct its cutters to any icebergs in their area. The cutters stay with the icebergs until they melt, meanwhile warning ships in the vicinity.*



A highly imaginative artist's impression of the sinking of the 'Titanic'.

WHO WAS TO BLAME?

Why did no ship arrive to help the *Titanic*? There were many ships in the area which picked up the *Titanic's* distress signals. It was the *Carpathia* which eventually picked up the survivors – but there were other ships nearer when the *Titanic* sank. At the United States Commission of Inquiry the captain of a much nearer vessel, which was within only 4 miles of the suffering *Titanic*, was convicted of culpable negligence. His ship was the *Californian*, also equipped with radio, but whose wireless operator was off duty. Members of the crew swore that they saw the distress signals, but nothing was done to help the signalling ship.

Who else was to blame? Possibly the *Titanic's* captain for making the speed of 24 knots in iceberg regions; possibly the wireless operator who failed to relay to the bridge iceberg warnings received at 11 p m on the night of the collision. The marked drop in temperature just before the collision, which everybody noticed and which sailors know can be a sign of icebergs, was taken little notice of. Perhaps the most fateful mistake of all was made by those who failed to provide enough lifeboats.

Letter from the Editor-in-Chief

37 HERTFORD STREET, LONDON, W.1.

PERHAPS you have been on a long car journey and have become rather bored by it. Maybe the scenery is uninteresting and you are one of those people who cannot read in cars. Maybe you are tired of talking to your companions. Whatever the reason, people are often bored by long car journeys if they are not driving. However, there is one thing which can add tremendous interest to any journey – that is, looking at town signs or signposts. Each place name can tell you a lot about how those cities, towns, or villages began. Of course, you probably know how to tell places founded by the Romans; their names end in 'caster', 'chester', or 'cester', which are derived from the Latin, *castra*, meaning a camp. There are other place names whose origin you can clearly see. 'Ford' is an example. But do you know how places with names ending in, say, 'ham', 'by', 'gill', and 'ings' originated? Or do you know how our counties got their names? The origin of the name Middlesex was very different to that of the name Hampshire. I have not the space to tell you any more about place names this week, but you will read more about them in my letter next week.

Historical Newspaper Competition

In two weeks' time the full results of this competition will be published in *Knowledge*.

John Chancellor

ADENOIDS

IN Gefion Platz in the city of Copenhagen there stands an impressive statue. It is like the statues of kings and of great statesmen which stand in so many of the cities of Europe. But it is, in fact, a monument to no such person. It is the statue of a man almost unknown outside Denmark; a man who, about a hundred years ago, made a discovery which has since saved innumerable children from years of suffering with a complaint which made their lives a misery.

Hans Wilhelm Meyer was born in the town of Frederika in Denmark on 25th October 1824. The son of a doctor, he decided to follow his father's profession, and in 1847, when he was 22, he qualified in medicine at the University of Copenhagen. For a time he worked in his father's practice, but he became a little dissatisfied with this life, and set out to travel through Europe, and thus broaden his experience of both medicine and people. Two years later, however, the young doctor was back in Copenhagen. He had decided to become an *otologist*, a specialist in diseases of the ears.

Dr Meyer's practice was a success, but among his patients there was one young lady whom he seemed quite unable to cure. She complained bitterly that she could never breathe through her nose, for it was always blocked up as if she had a severe cold. What was worse, she was going deaf. Carefully Dr Meyer examined her nose, her throat, and her ears once again. Then, with the utmost gentleness, he placed a finger in his patient's mouth and, with its tip, felt around in her throat. What the astonished doctor discovered there convinced him that only by an operation was he likely to achieve a cure. The operation which he devised and performed on this patient was quite new, and the result was miraculous. Almost immediately the young lady was able to breathe through her nose, and in a little while she could hear properly too.

The success of the new operation no doubt gratified Dr Meyer as much as it pleased his patient, but it was probably not unexpected. The doctor's knowledge of the anatomy and the physiology of the nose and the throat led to the correct diagnosis, the correct treatment, and a complete cure.

The anatomy of the human nose and throat is shown in the illustration. At the top of the picture is the *nasal cavity*, extending from the nose in the front to the space called the *naso-pharynx* at the back. The *palate* separates the nasal cavity from the mouth below, and it hides the naso-pharynx from view. Underneath the palate, the mouth extends from the lips to the *pharynx*. Thus there are two routes into the pharynx: one through the nose and the naso-pharynx, and the other through the mouth. Breath can be drawn through either, though during normal breathing only the nasal route is used, and the mouth is kept closed.

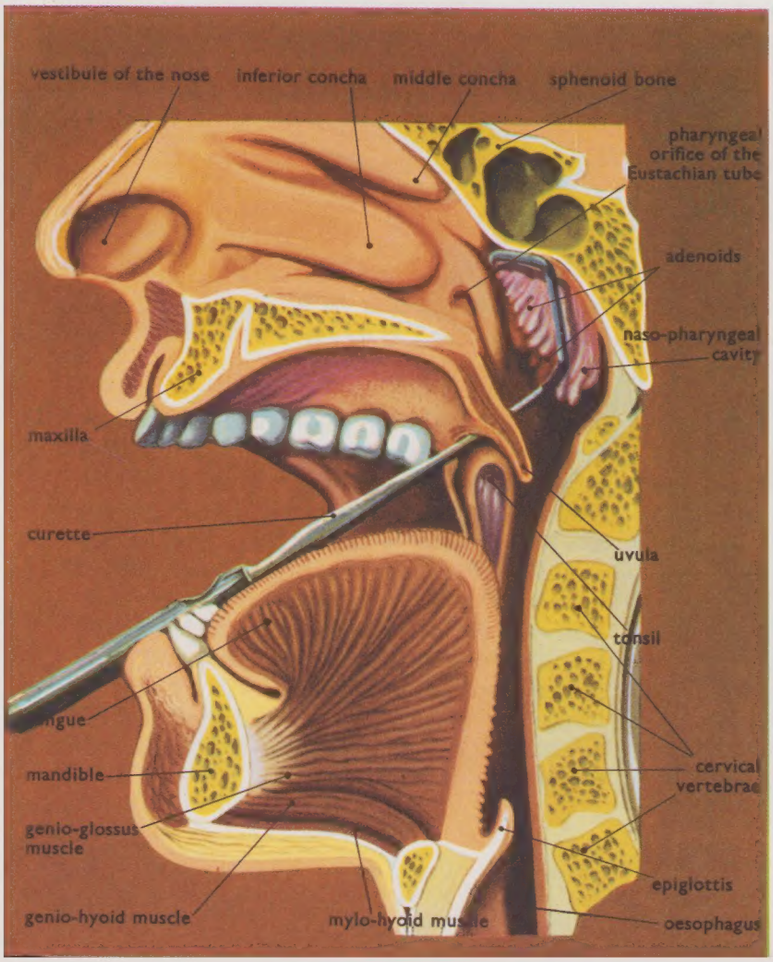
At the back of the nose the passageway for air is quite narrow, and on the rear wall of the naso-pharynx just opposite this narrow part there lies the *pharyngeal tonsil*. This is a nodule of lymphoid tissue much like the tonsils in the throat. Though the pharyngeal tonsil is tucked out of sight behind the palate, Dr Meyer was able to feel it quite easily when he put his finger into his patient's throat. He realised that in this patient the pharyngeal tonsil was so large that it blocked both her naso-pharynx and the little openings of the Eustachian tubes which lead to the ears. When he operated he removed the overgrown pharyngeal tonsil, and in doing so reopened both the pharynx and the tubes.

The success of the new operation

Once the success of Dr Meyer's operation became known, many new patients, particularly children, were brought to him. Almost all of them were unable to breathe through their noses, and because of this they pronounced their 'm's like 'b's and their 'n's like 'd's. Many snored horribly every night, and some were deaf. In the course of 18 months Dr Meyer performed his operation 102 times, and he sent an account of his work to the Medico-Chirurgical Society in London. It was called *On the Adenoid Vegetations in the Naso-pharyngeal Cavity*, and from this formidable title we have taken the term *adenoids*.

In his operation for the removal of the pharyngeal tonsil, or adenoids, Dr Meyer used an instrument called a *curette*. It was a sharp ring attached to a long, thin handle. His patients must have been very brave, for he operated on them through their noses and without an anaesthetic. Happily those days are gone for ever. It is now common practice to remove the adenoids at the same time as the tonsils, and for this dual operation a general anaesthetic is always given. The surgeon works through the patient's mouth, using a sharp, cleverly shaped curette like the one shown in the illustration. The operation is not a serious one and it is usual for patients to return home the next day.

Although many children never need an operation for adenoids, this does not mean that they do not have a pharyngeal tonsil. A relatively large pharyngeal tonsil is present in the naso-pharynx of every child when it is born. Usually, as the child grows up, this organ slowly shrinks and so never causes any trouble. Only in unlucky children does it swell to fill the naso-pharynx. Unfortunately there is a rather large number of these unlucky children, and tens of thousands of them have their adenoids removed every year. Even you may be one of the many who have benefited from this operation. If so, there is good cause for you to be grateful to the Danish otologist whose statue stands in a Copenhagen square.

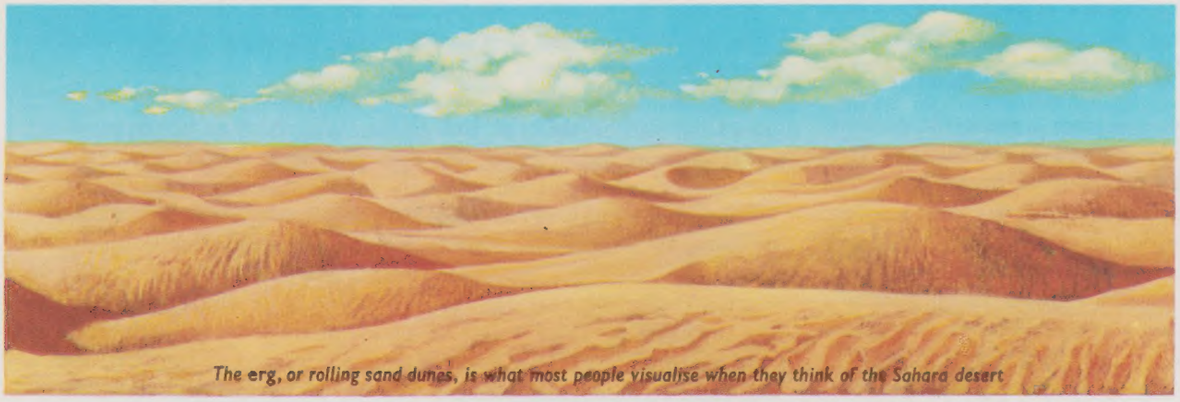


This sectional view of the head and neck shows how an enlarged naso-pharyngeal tonsil (adenoids) blocks the nasal airway into the pharynx. The curette is poised ready to detach the adenoids

THE SAHARA

THE Sahara is one of the most inhospitable places on earth; but 30 or 40 thousand years ago it was very different. Then, herds of elephants, buffalo, giraffes, and flocks of ostriches roamed its green and well-watered expanses. There were also human inhabitants (see page 542) who have left marks of quite an advanced civilisation.

But then the ice covering much of Europe receded northward, and the Sahara became warmer. The rivers dried up; the rain became less. Gradually the great expanse turned into one of the most forbidding areas in the world – a seemingly endless stretch of sand blistered by the sun in the day, and icy cold at night.



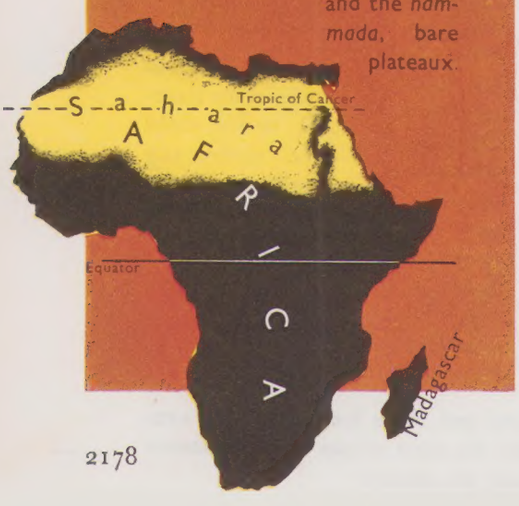
The erg, *or rolling sand dunes, is what most people visualise when they think of the Sahara desert*

THE LARGEST DESERT IN THE WORLD

The Sahara lies across North Africa, stretching from the Atlantic Ocean in the west to the Red Sea in the east. It is about 3,000 miles across, and 1,000 from north to south, with a total area of 3,000,000 square miles. But there are no clearly defined limits to the Sahara, and it is generally taken that places with less than 10 inches of rain each year in the north, and less than 15 inches in the south (where evaporation is much greater), are within the desert.

There are three main types of scenery in the Sahara: the erg, desert with shifting sand dunes; the *reg*, rocky plains; and the *hammada*, bare plateaux.

The geographical position of the Sahara



The climate

The Sahara is one of the hottest regions in the world, and the surface of the ground may reach 170°F. But at night the temperature drops sharply, in some places to below freezing point. These great extremes of temperature have helped to make the Sahara a desert region. The fierce heat in the daytime makes the rocks expand, while the sharp drop in temperature at night and the constant evaporation make them crack. The strong winds grind the fragments together, making sand.

Water is scarce in much of the Sahara, though in mountainous areas rain falls fairly regularly. Elsewhere it falls only about once in two to five years. Despite this, the whole desert is not just one sea of sand. There are plants like the thorny tamarisk and jujube shrubs, acacia and betoum trees, and ephemeral plants called *acheb* which spring up briefly after rain.

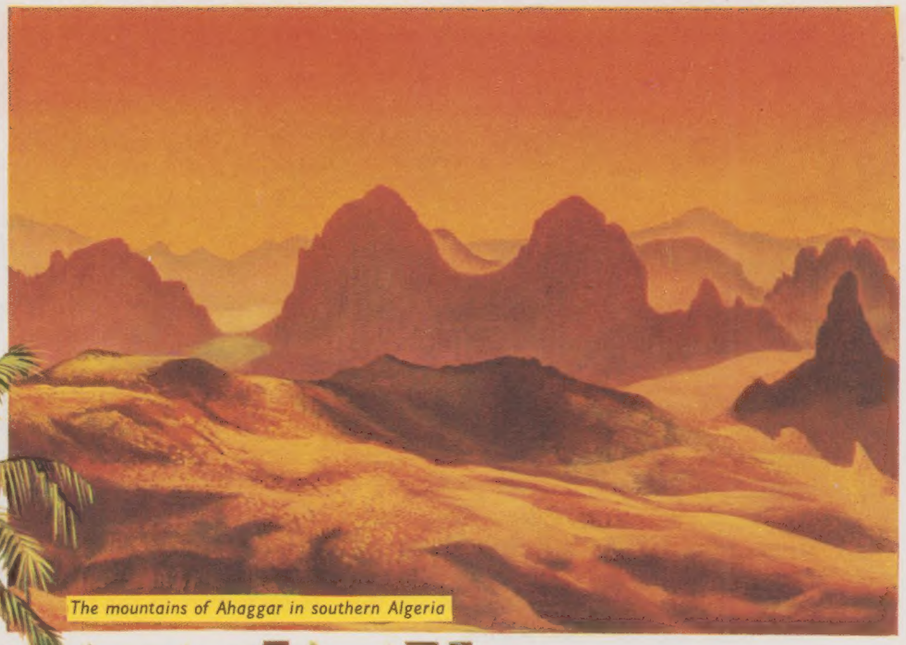
Wherever water can be found at or near the surface, oases are found. Date palms, which provide the main food for the people of the desert, are grown here, while in their shade citrus trees, figs, peaches, apricots, and cereal crops are cultivated.

For centuries the nomadic tribes of the desert have traded in the Sahara.

In the hammada, *rocks are weathered into fantastic shapes by the strong winds*

They supply the desert peoples with grain, wool, and manufactured goods in exchange for dates grown in the oases. Salt is carried across the Sahara by huge caravans of camels, moving slowly from oasis to oasis. Camels provide the main form of desert transport. Regular, though infrequent, buses cross the desert by two roads. Railways do not penetrate beyond the fringes, but air routes pass over the desert, and some planes land on little improvised airstrips to bring supplies to the people living there. Larger airports, like those at Tripoli and Kano, are on the edge of the Sahara.

The Sahara contains, as well as vast areas of sand, stretches of stony desert



The mountains of Ahaggar in southern Algeria

A lush oasis giving welcome shade from the desert sun

PRESENT-DAY IMPORTANCE

Much of the Sahara belongs to Algeria, which gained its independence in 1962. Algeria has allowed its former rulers, the French, to keep their atomic base on a 15-year lease, which may be renewed by agreement, and to use various military installations. The French are also allowed to mine for oil in Algeria. There is reason to believe that there are large oil deposits, although the mining costs are exceptionally heavy, and conditions are difficult.

Plans for developing the Sahara are hampered by the difficulty of irrigation, and of making accurate surveys. But it is hoped that some day part at least of this great stretch of Africa will be productive and fertile once more.

Desert animals

Thousands of years ago there were many different animals in the Sahara. But since then it has become hotter and drier. The few wild animals of the present-day Sahara include, on the fringes, goats, gazelles, jackals, foxes, honey badgers and barbary apes. Horned vipers, scorpions, and lizards are common, and so are locusts, flies, and ticks. Among the birds, vultures are abundant, while bustards are found in the south, and there are still a few ostriches. Domestic animals, including sheep, goats, and the all-important camel, are grazed at the oases.

PEOPLES OF THE DESERT

Probably the first inhabitants of the Sahara were negroes, who were succeeded first by Berbers and then by the Arabs, who imposed their language and the religion of Islam on the desert people. From these different races have developed the different tribes living in the Sahara today. There are three main groups: the Touareg, the Tibbu, and the Moors, and many other, smaller tribes. The chief distinction is between nomadic tribes who wander over the desert in search of grazing for their flocks and herds, and settled peoples who live at the oases, irrigating and cultivating the land.

HISTORY OF AUSTRIA

'IT is for Austria to rule the whole world.' Frederick III, a mediaeval emperor of Austria, proclaimed this ambitious programme with symbols stamped on his jewellery. These symbols, AEIOU (*Austriae Est Imperare Orbi Universo*), typify the arrogance of mediaeval Austria. Although a fitting motto for the nation which was to produce Hitler, Austria's destiny was never to be as spectacular as this. But Austria was always to be of the utmost significance. It stood as a bulwark against the threatening tribes of the East – Avars, Huns, Mongols, and Turks – which for centuries looked like engulfing Europe. Austria's place has been that where the West ends and the East begins.

Osterreich

The history of modern Austria began in 976, when Leopold of Babenberg was put in control of the Ostmark of the German Empire. A *mark*, like an English *march*, was an area behind a threatened border, and the *margrave* (lord of the mark) was responsible for the defence of that border. The Babenbergs became one of the great families of the Empire. In 1156 Ostmark – now known as Osterreich (eastern state) – became a duchy. The Osterreich grew in power and territory. In 1246, however, the last remaining male Babenberg was killed in battle. Austria then came under the influence of the Kingdom of Bohemia. But in 1273 a vigorous and able king of Germany, Rudolf of Habsburg, was crowned. He determined to acquire Austria. In 1276 he defeated the king of Bohemia, and annexed Austria for his family. The Habsburgs were now one of the most important ruling houses in the Empire. For the next 150 years they shared the Imperial title with the other great families of Germany, after which the title Holy Roman Emperor fell permanently into Habsburg hands. In 1477 Emperor Frederick III of Habsburg married his son Maximilian to Mary, heiress of the wealthy lands of Burgundy and the Netherlands. This example was followed by Maximilian himself, ruler of Austria from 1493 to 1519, who in 1496 married his son Philip to Joanna the Mad, daughter of Ferdinand and Isabella of Spain. The result was that his grandson Charles V became King of Spain as well as Emperor of Austria and Holy Roman Emperor. Maximilian also married his grandson Ferdinand I to the daughter of the Bohemian king and gained Bohemia and Hungary.

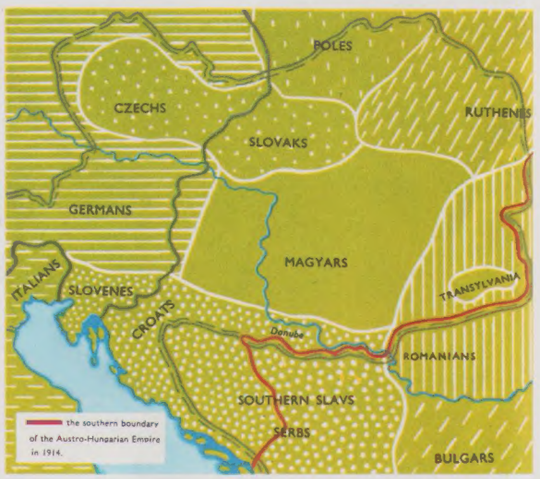
The Reformation hit the Habsburg rulers of Austria harder than any other monarchs. When Charles V became ruler of Austria and Spain, and was in 1519 elected Holy Roman Emperor, he dreamed of founding a vast Catholic empire across Europe. But parts of the Empire, like Bohemia and Hungary, were rapidly developing as centres of the new Protestant faith. Charles's title Holy Roman Emperor gave him a claim to participate in the rule of the German states, and Germany was the home of Lutheranism. Prussia, Saxony, and others adopted this faith, and for some time after this religious discord was to be the main feature of the Holy Roman Empire.

War and peace

A temporary compromise was reached with the Peace of Augsburg in 1555, but strife was renewed with Charles's successors. Austria became the centre of the Catholic Counter-Reformation, and launched an attack on the Protestants in her own dominions. In 1618 two of Austria's Catholic officials were thrown out of a high window by zealous Protestants in Bohemia. 'Let their Mary save them now,' the would-be assassins declared gleefully. Looking down and seeing them still alive, they could only exclaim: 'Good Heavens, she has!' This was the signal for Bohemia to revolt. A Protestant army marched on Vienna. All the Protestants of the Empire rallied to the Bohemian side, while Austria and such Catholic states in Germany as Bavaria opposed them. This was the Thirty Years War. It began as a runaway victory for the Austrians, but the intervention of Sweden and France turned the tide in favour of the Protestants. The Emperor Ferdinand II (1619–1637) died before the war was over, and it was left to his successor Ferdinand III (1637–1651) to bring the war to an end at the Peace of Westphalia in 1648. Austria was defeated and Protestantism in both Germany and the Empire was firmly established.

France was now the implacable enemy of Austria. Both were jealous of each other's influence in Germany – Austria influenced the southern Catholic states and France influenced the northern Protestants. England favoured Austria, since, by the close of the 17th century, she was a firm enemy of the French. When the French King Louis XIV installed his grandson Philip on the Spanish throne in 1700, England at once took up arms in favour of the claim of Charles VI of Austria. The War of the Spanish Succession resulted in the defeat of France, though Charles VI did not become king of Spain.

Charles VI died in 1740 and was succeeded by one of the greatest of all Austrian rulers, Maria Theresa (see page 1680). But her accession produced a war, since the powers of Europe could not resist the sight of so much wealth in the hands of so young a queen. Prussia, Saxony, Spain, and Bavaria all claimed a share of her territory. But they had misjudged the Empress. Austria remained virtually intact after the War of the Austrian Succession. Frederick II of Prussia, it is true, gained Silesia, and kept it despite Maria's efforts during the Seven Years War; otherwise Austria only surrendered a few territories in Lombardy. The next 20 years were peaceful ones for the Habsburgs. Maria Theresa and her son Joseph II made great reforms in their dominions, but unfortunately these reforms all took the form of centralisation. The non-German races of the Empire were beginning to resent the rule of Austria. Joseph's centralising policy brought to the surface the rebellious nationalism which was to become an increasingly menacing problem throughout the 19th century.



Map showing the different peoples of the Austrian Empire

The reckoning

Napoleon abolished the Holy Roman Empire in 1806, after routing the Austrians at the battle of Austerlitz. Never again was an Austrian ruler to be a Holy Roman Emperor, and nor indeed was anyone. But the Habsburg rule of Austria remained. The harsh Metternich controlled Austrian affairs as Chancellor from 1809 until 1848. It was largely his autocratic rule that brought nationalist feeling against the Austrian 'police state' government to a head in 'The Year of Revolutions' of 1848.

As a result of the revolution in Austria Metternich fled the country. Risings occurred in Vienna, Prague, Budapest, and the Austrian possessions in north Italy (Lombardy, Tuscany, Modena, and Venetia). It took Schwarzenberg, the new Chancellor, 18 months to restore the full oppressive machinery of the monarchy throughout the Habsburg dominions. In 1859 Italy again broke into revolt. The Kingdom of Sardinia supported the claims of the Habsburg-ruled Italian states to be united with her in a new kingdom of Italy. As a result Austria had, by 1860, lost virtually all her Italian possessions except Venetia to the new Italian kingdom. Further disasters followed. Prussia defeated Austria in 1866 and Bismarck insisted that Venetia should be handed over to Italy.

But Austria was not only expelled from Italy; she had also lost that influence in Germany she had held for so long as the most powerful Germanic state. After Bismarck founded the German Empire in 1871, he refused to include Austria, declaring that he would not 'shackle the trim Prussian frigate to the worm-eaten Austrian galleon'.

Good intentions

With Austria's leadership in Germany and Italy ended, the Emperor Franz Joseph clearly needed a new policy. This new policy was inaugurated in 1867, when he made the decision to divide the government of his vast empire. Hungary was allowed to rule herself and the empire became known as the Austro-Hungarian Empire. The Germans were the ruling class in Austria; the Magyars in Hungary. A dual empire was thus substituted for the 'indivisible' centralised state which had existed since the days of Maria Theresa. Time was to prove how totally misguided this new policy was. In the first place, the favoured position of the Magyars angered the Czechs, who agitated for similar concessions from Franz Joseph. Secondly, and far more serious, the other minority races soon learned that Magyar supremacy was as bad as, if not worse than, being dominated by Germans. This was the basis of the so-called 'Southern Slav' problem. The Southern Slavs were the Serbs, Croats, and Slovenes, living in the southern part of the Empire. Next to this part of the Empire was the independent Slav state of Serbia. Serbia began a giant propaganda campaign against the Austrian government on behalf of her brother Slavs under Austrian rule. The Austrian Slavs were equally vociferous in their claims for incorporation into Serbia, and so a bitter enmity grew up between Austria and Serbia.

Franz Ferdinand, the heir to the Austrian throne, planned to reconstruct the monarchy into a federation of national states. In this way he hoped to give the minority races their freedom. Nothing could be done while Franz Joseph lived, for he would not break his agreement with the Magyars; but Franz Ferdinand hoped eventually to let other races share the Magyars' privileges. It alarmed Serbia, who feared that if the Austrian Serbs gained their independence, they might not want to be incorporated into Serbia.

Wiped off the map

Hostility grew, and on 28th June 1914 Franz Ferdinand was assassinated by a Serbian fanatic while on a visit to Sarajevo, capital of Bosnia. Austria immediately retaliated and declared war on Serbia. The greatest Slav power, Russia, together with her ally France, came to the aid of Serbia. Germany rushed to the aid of Austria, and with the intervention of Britain against Germany the First World War had begun. The war proved a disaster for Austria. She emerged from the peace treaty of Versailles stripped of nearly all her historic empire. She lost not only her non-German lands and her connection with Hungary but also the German districts in Bohemia and the South Tyrol. For the first time in her history Austria was a purely German-speaking country; and she was a republic. Franz Joseph had died in 1916, and his successor, Charles I, fled into exile at the end of the war. To the many Austrians who had long resented being cut off from Germany, this seemed the obvious moment for a reunion. But this was strictly forbidden by the victorious powers at the end of the war. The Austrians were furious. Many felt that they were being cheated of their true destiny. In 1933, an Austrian, Adolf Hitler, became dictator of Germany, and he increased agitation in both Germany and Austria for a political union between the two. Hitler met solid opposition from the Austrian Chancellor, Dolfuss, who rightly considered that Austria needed protection *from* Germany, not union *with* her. The Nazis got their typical revenge: Dolfuss was murdered by their agents in 1934. He was succeeded by Schuschnigg, a man no match for Hitler – indeed the type of statesman with whom Hitler was most successful in dealing. Hitler marched on Austria. Schuschnigg's reaction was: 'We are resolved on no account . . . to cause the shedding of any German blood.' He failed, like so many Germans and Austrians, to see the vital difference between German blood and the German state: that he would have performed a 'patriotic' duty if he had opposed the German state for the sake of the German blood in Austria. Refusing to offer any resistance to his Nazi 'blood brothers', he retired with the optimistic prayer 'God protect Austria'. On 11th March 1938 Austria was wiped from the map and became part of Germany.

Maria Theresa (1740–1780)

Franz Joseph (1848–1916)

Watchdog of Europe

Those Austrians who longed for union with Germany had not realised the horror of what it would involve. It was only when the barrier to union was forcibly removed that they realised how necessary this barrier had been, and discovered that they were, after all, a nation in their own right. At the end of the war in 1945, Austria was separated from Germany and divided into four zones, which were occupied by the victorious powers until 1955, when at last Austria was free to rule herself in her own interests.

Today the menace in the East is the threat of Communism. Austria is today what she has always been – a key country in the defence of western civilisation.

BUDDHISM

A Buddhist monk

BUDDHISM is like Protestantism; it began as a protest against an established religion and developed as a vast religious movement of its own with converts to be numbered in millions. Buddhism is also like Protestantism because it is divided into many sects with great differences between them.

The word Buddha means 'the Enlightened One'. Buddha's real name was Siddartha Gotama. He was born at Kapilavastu in Northern India in about 560 B C. His concern for all the suffering he saw around him – disease, death, poverty, and frustration – led him at the age of 29 to abandon his wife and young child and become a 'Holy Man' searching for the Truth. Above all he wanted to come to terms with all the suffering which seemed so much a part of the human life.

Buddha found the prevalent Hindu religion unsatisfactory. Hinduism belongs to that group of religions called *monistic*. That is, Hindus believe that apart from everything we see, feel, smell, hear, or think, there is an indefinable Reality or 'World Spirit' which 'makes everything tick'. This Reality Hindus call *Brahman*. They believe that the soul is born again and again at a higher or lower level of life according to its deserts until, after its holiest possible life, it becomes absorbed in *Brahman* and is never born again. This is the state of eternal bliss called *Nirvana*.

The caste system is in line with this religious teaching. In this system men traditionally belong to one of four castes, originally issued from Brahma's body, the holy Brahmin priests from his mouth, warriors from his breast, tradesmen and craftsmen from his thighs, and slaves from his feet. Since their status in this life reflects their merit in the last, the priests enjoy a special respect.

Buddha rejected the idea of *Brahman*, and the caste system. He believed that everybody has the ability to lead a 'holiest' life and that this capacity was not just confined to the Brahmin caste. He also considered women to be capable of the 'holiest' life. Their status had been very low under rigid Hinduism, and indeed the practice of *suttee* (burning of widows on the husband's funeral pyre) was carried out in some Hindu groups until as recently as a century ago.

Buddha believed that after its holiest life the soul was simply extinguished, and neither reborn on earth nor absorbed into any eternal World Spirit. Buddhist *Nirvana* is a state of extinction.

Buddha retained the Hindu doctrine of reincarnation or *Karma*. That is why good Buddhists are always great animal lovers and will avoid treading on even the humblest of insects. They respect the right of all creatures to be allowed to work their way up the scale to the human life and, ultimately, the 'holiest' human life.

But why should the object of their struggle be complete extinction and why should a man desire simply to fade into nothingness?

The answer the Buddhist gives is that life is not worth living. It is simply a craving after unfulfilled ambitions, and it is this unpleasant craving which is the force behind rebirth. Once one has learned to overcome desire, the 'harsh necessity' to be born again disappears.

Buddha's four Noble Truths state: (1) life is suffering; (2) all suffering is caused by craving for life; (3) the way of release from suffering is to cease craving for life; (4) to make that craving cease one must follow the Noble Eightfold Path of right understanding, right thought, right speech, right action, right livelihood, right effort, right mindfulness, and right concentration.

PROGRESS OF BUDDHISM

The key figure in the expansion of Buddhism was King Asoka, who became king of a large part of India in about 270 B C. He converted not only his own subjects but also sent Buddhist missions to other lands. But Buddhism was not destined to flourish in India, where it was virtually obliterated by a revived Hinduism and the religion of Islam that came from the west. Instead it moved north and south.

In Asoka's reign Buddhism split into two main groups, *Hinayana*, The Small Vehicle, and *Mahayana*, The Great Vehicle. *Hinayana* flourished in the south, in Ceylon, Burma, and Thailand, while *Mahayana* was successful in China, Korea, Tibet, and Japan.

Hinayana is the purest form of Buddhism. Its followers regard Buddha as simply a man who laid down certain rules of conduct and not as a god to be worshipped. In Ceylon, the centre of *Hinayana*, is Buddhism's most celebrated relic, one of Buddha's teeth.

Mahayana is a corrupted form of Buddhism which regards Buddha as one of innumerable divine beings. Its followers also worship the Spirit which inspired the Buddhas. They believe in angels and demons, while some groups even have a heaven and hell through which the soul must pass before attaining *Nirvana*. There are many varieties of *Mahayana*. In Tibet monks believe that written prayers enclosed in wheels will ascend to Buddha when the 'prayer wheels' are turned. In Japan *Zen Buddhism* places great emphasis on contemplation, with techniques quite like *yoga* to aid concentration.

ORGANISATION

All Buddhist sects are monastic because of the necessity for uninterrupted meditation. They have monks and abbots as part of an elaborate hierarchy. The basic documents of *Hinayana* are the *Three Baskets of Tradition*, or *Tipitaka*. They were approved in the reign of Asoka. *Mahayana* has its own version of *Tipitaka*.

Fossilised tree-trunks, from a forest of siliceous fossils in Arizona

THE EARLIEST LAND PLANTS

TRY to imagine the land totally without vegetation. Not only would there be no trees or grass or flowers, but there would be no soil either. The surface of the earth would be bare rock with only sand and gravel in the hollows. Conditions would be rather like those of the driest stony deserts, but they would prevail everywhere, regardless of climate and rainfall. There is good reason to suppose that up to 450 million years ago this is just what the earth was like.

Plants preserved in stone

The picture on the left is of a plant fossil, preserved in a kind of rock called shale and dating from the Carboniferous period, about 300 million years ago. At that time great forests of primitive plants grew in enormous swamps, hundreds of square miles in extent. Often they fell down into the water and became covered with mud; later the mud hardened into clay and shale. Where masses of vegetation had been buried, seams of coal were formed; when separate leaves and stems were enclosed between layers or strata of shale, they also turned into black carbon, but their shape and the details of their surfaces were preserved. It is fossil plants of this kind that enable botanists to study the vegetation of former ages and to trace the evolutionary history of plants through geological time.

A fossil, preserved in shale, of a plant that lived in the Carboniferous period, about 300 million years ago

THE MOST ANCIENT PLANTS

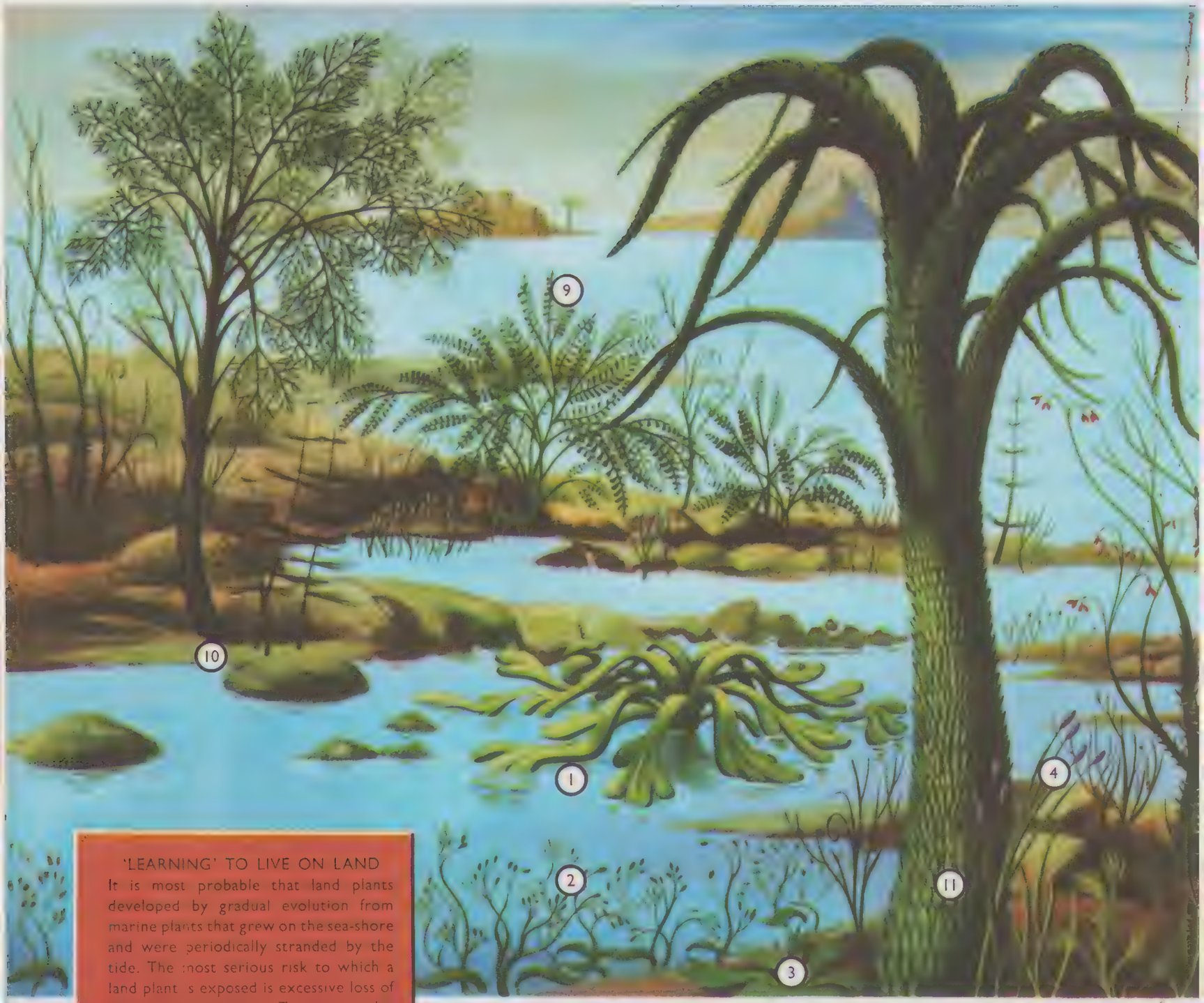
For hundreds of millions of years before they invaded the land, plants lived in the sea. Most of these were algae, which are represented now by the seaweeds and by many microscopic plants. Traces of fossil algae, whose age is estimated at 2,700 million years, have been found in Rhodesia.

The earliest recognisable fossils of land plants occur in Australia, and date from the Silurian period, between 400 and 440 million years ago. In Aberdeenshire in Scotland there are flinty rocks of the Devonian period containing very well-preserved land plants; these are about 350 million years old.

SILICEOUS PLANT FOSSILS

Silex is the Latin for flint, and the most perfect plant fossils of all are those preserved in rock of this kind, such as the ones from Scotland which we have just mentioned. In this type of preservation the substance of the plant was gradually replaced by silica (the chemist's name for flint and quartz) so that minute internal structures are preserved. By preparing thin slices of the rock and examining them with a powerful microscope, a botanist can study the plants in great detail.

Sometimes whole forests were preserved in silica.



Types of land plants that lived in the later part of the Palaeozoic era, about 270

'LEARNING' TO LIVE ON LAND

It is most probable that land plants developed by gradual evolution from marine plants that grew on the sea-shore and were periodically stranded by the tide. The most serious risk to which a land plant is exposed is excessive loss of water by evaporation. To prevent this the plants developed a thin skin, called the cuticle which covers the stem and leaves and is almost watertight. Since a land plant normally can absorb water only where it is in contact with the soil, it must be able to convey water from one part of its body to another. In response to this need a system of fine tubes, called vascular tissue, has been developed. Other characteristic features of land plants are special water-absorbing organs, the roots, and stiffening tissue to enable the plant to stand upright; wood is a highly developed tissue of this kind.

Primitive plants, like mosses and ferns, are more dependent on easily available water than are the flowering plants.

Here are some of the earliest land plants, drawn from information based on the study of their fossils. For convenience plants which lived at different geological periods have been included in the same landscape; they did not all live at the same time.

① *Nematophyton* lived in the Silurian and Devonian periods, around 400 million years ago. It was quite unlike any modern plant and is generally regarded as a sort of alga, and as transitional between aquatic and land plants. It must have been quite large, as pieces of stem up to two feet in diameter have been recorded; the stems contained vascular tissue.

② *Taeniocrada* was flattened and branched in form, and is known to have reproduced itself by means of spores, as the capsules containing them (sporangia) have been found as fossils. It lived about the same time as *Nematophyton*. *Sciadophyton* ③ was similar to *Taeniocrada*.

④ *Rhynia* is a plant also of the Devonian age, of which fossils have been found preserved in chert (a kind of flint) at Rhynie in Scotland. It was a slender, reed-like plant, and both stems and sporangia are so perfectly preserved that we know a lot about its structure. A living genus of plants called *Psilotum* is very similar to it.

to 400 million years ago. It was during this period of time that plants first invaded the land

⑤ and ⑥ *Pseudosporochnus* and *Duisbergia* are larger, tree-like plants of the Devonian age, 350 to 400 million years ago. The coloured structures hanging from the branches are not, of course, flowers, but spore-cases or sporangia. *Psilophyton* ⑦ is another tree-like, spore-bearing plant which lived in the Devonian age.

⑧ *Asterocalamites* lived in late Devonian times and on into the next period, the Carboniferous (about 300 to 350 million years ago). They belong to a group of plants represented today by the mare's-tails (*Equisetum*). The mare's-tail is therefore a true 'living fossil' among plants.

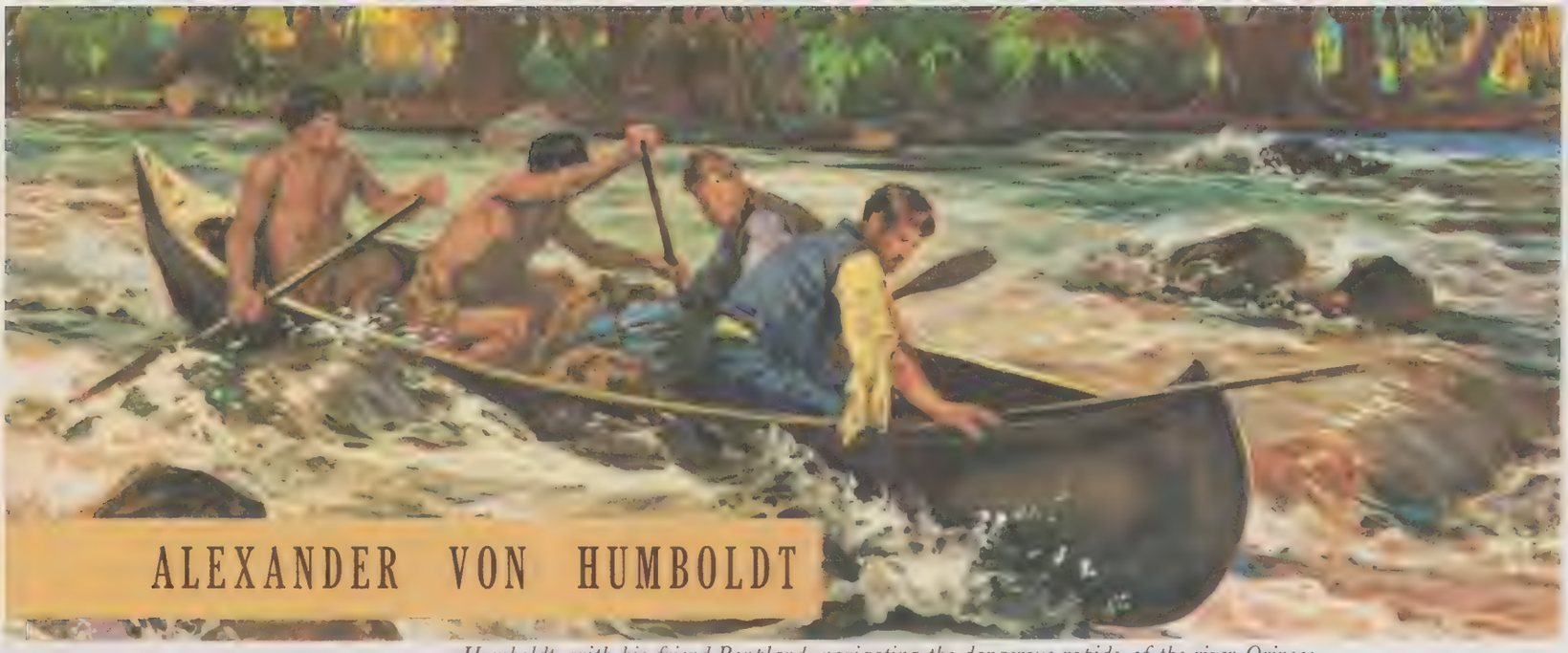
⑨ and ⑭ *Archaeopteris* and *Aneurophyton* were large fern-like plants of the later part of the Devonian period. Plants of this kind evolved rapidly at this time and were present in great variety in the great forests of the Carboniferous period, which formed valuable deposits of coal.

⑪ *Archaeosigillaria* lived at the same time as the last two plants named and also had many descendants in the Carboniferous period. It was tree-like, and its trunk and branches were closely covered with scale-like leaves.

⑫ *Pitys* was a large, tree-like plant of the lower Carboniferous period (350 million years ago) and is the earliest representative of the Order Cordaitales. These were the earliest seed-bearing plants and are thought to be ancestors of the conifers – that is, the pines and firs of the present day.

The plants we have illustrated all grew during the middle part of the Palaeozoic era. That is near the end of the Silurian period, through the Devonian, to the early Carboniferous period.

The great forests from which most of the world's coal is formed grew in late Carboniferous times, and the flowering plants of the world appeared later still, in the Mesozoic era.



ALEXANDER VON HUMBOLDT

Humboldt, with his friend Bonpland, navigating the dangerous rapids of the river Orinoco

PLANTS, shells, and insects fascinated the young Alexander von Humboldt. He loved collecting and labelling them meticulously; so much so that he became known as the 'little apothecary'. His parents did not wholly approve of this enthusiasm, since they wanted their son to be a famous politician. Alexander was certainly to gain fame; at the height of his career people said he was, after Napoleon Bonaparte, the best-known man in Europe. But it was as a geographer and explorer, not as a politician, that he became famous. In fact, he has been called the founder of modern geography.

The young explorer

Alexander was born in 1769, of a good Pomeranian family. His father, a major in the Prussian army, was made a royal chamberlain, so Alexander was brought up in comfortable circumstances. His parents sent him to study economics at the University of Gottingen, but Alexander did not forget his early love of nature, and in his vacation made a journey of scientific exploration up the river Rhine with a group of friends.

After the Rhine expedition Alexander decided to give up politics and devote himself to scientific exploration. At first his travels did not take him far afield. In 1790 he visited England, and five years later went on a botany expedition to Switzerland and Italy. Soon after he was admitted to the circle of the famous group of intellectuals at Weimar, which included the poet Goethe (see page 2030).

The death of Alexander's mother in 1796 finally left him free to undertake the travels for which he was to become famous. He set out with a friend, Aimé Bonpland, intending to join Napoleon in Egypt, but they got side-tracked to Madrid where they met an important Spanish minister, d'Urquijo. This meeting changed Alexander's whole life. The minister persuaded him to abandon the Egyptian project and turn his attention instead to the relatively unknown and little explored part of the Spanish Empire in South America. So it was that in June 1799 Alexander left Spain for the New World. His discoveries there amply fulfilled the hopes of the Spanish minister. Moreover, on arrival at Cumana in Venezuela, Alexander observed a meteor shower – it was after this observation that people began to take a real interest in meteorology. He then spent four months exploring the Amazon and Orinoco rivers.

◀ *Alexander Humboldt* (1769–1859)

By this expedition Alexander began the study of physical geography and meteorology as we know it today. Its importance lay not only in the amount of new information gathered but also in the scientific method which Humboldt, for the first time among explorers, used to classify and illuminate his observations. He devised a means of comparing the climates in different countries by the use of isothermal lines (lines connecting places with similar temperatures). He investigated the geography of plants, studying the effects of physical conditions on the distribution of organic life. He discovered that the force of magnetism is less at the equator than at the poles.

European acclaim

Four years after his return to Europe, Alexander settled in Paris. He had never liked his native Berlin, but he loved the French capital, where he found the scientific co-operation he needed, and the social stimulus he enjoyed. He began to record his observations and draw scientific conclusions from his South American experiences. He thought the task would take two years; in fact, it took him 21 – and even then was left unfinished. Europe sought to honour him and he was eagerly welcomed by the academic societies of many countries. At the age of 60 Alexander made a journey through the Russian Empire, covering 9,614 miles in 25 weeks. The most important result of this visit to Russia was the arrangement he made with the Russian government for the establishment of a line of meteorological stations across North Asia. In 1836 an agreement with the Royal Society put the British Dominions at his disposal in a similar way.

Humboldt was one of the first to realise that science should be international; and one of the first to achieve co-operation between scientists working in different parts of the world. This has been one of his most lasting contributions to science. Humboldt was 76 when he began his last great work – his five-volume book called *Kosmos*, which was to cover the whole scientific knowledge of the time. He died on 6th May 1859, just before his 90th birthday. Honoured in death as in life, he was given a state funeral in Berlin.

ELECTRIC MOTORS

THE electric motor is undoubtedly one of the most helpful modern inventions. It is used in factories to drive machinery, for electric trains and trolley buses, and to power such everyday things as food mixers, polishers, vacuum cleaners, record players, drills, sewing machines, and electric razors.

What else makes this sort of motor so popular? One reason is its efficiency. Figures show that it is much more efficient than steam engines, steam turbines, or petrol engines. It is simple to work; it does not cause vibration; it is fairly silent; it has few moving parts, and is therefore subject to little wear and tear; and it can be easily started, accelerated, slowed down, and stopped. In fact for most purposes it is ideal.

The electric motor does have one great disadvantage: it has to be supplied with electricity. It must either be connected to an electric supply line or to a very heavy battery. This is why the electric motor is unsuitable for cars, motor cycles, and so on. But many machines do not need to be moved about, or at any rate are not hampered by a flex attaching them to a power point, and for all these the electric motor can be used.

A reversible machine

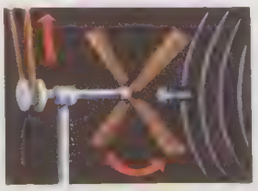
We have already described the dynamo (page 2126) and the basic principle of how electricity is generated. We have seen that the dynamo converts mechanical energy, such as the force of falling water, the pressure of steam, or even the turning of bicycle wheels, into electrical energy. We can in fact say that, in the dynamo, mechanical energy goes in and electrical energy comes out.

The same machine can also work in the opposite way; that is, it can convert electrical energy into mechanical energy. In other words, it can become an electric motor. Machines which are capable of lending themselves to a complete reversal of their functions, like this, are called *reversible*.

The pictures at the bottom of this page give two examples of reversible machines. The top left picture shows a man turning, with mechanical energy, a handle which rotates the blades of a fan. They make a current of air. The next picture shows the reverse happening: a current of air has turned the blades of the fan, and consequently the shaft. Instead of being connected to a handle, the shaft is now connected to a pulley, and this carries away mechanical energy for us to use.

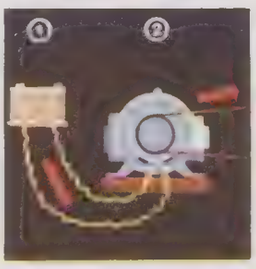
The lower two pictures are rather more complicated. On the left is a petrol engine, producing mechanical energy. This is connected to the dynamo, which converts it into electrical energy. The lower right-hand picture shows an electric battery supplying energy to an electric motor. This motor converts it into mechanical energy again. In this way mechanical energy, collected at places like waterfalls, where it is readily and cheaply available, can be transformed into electrical energy, transferred over long distances to places where mechanical energy is not so easily come by, and reconverted back to mechanical energy. This is one of the great benefits the electric motor has brought to man.

This ventilating fan is consuming mechanical energy in order to produce a current of air



If a current of air blows on to the blades of the fan, it will turn, giving us mechanical energy

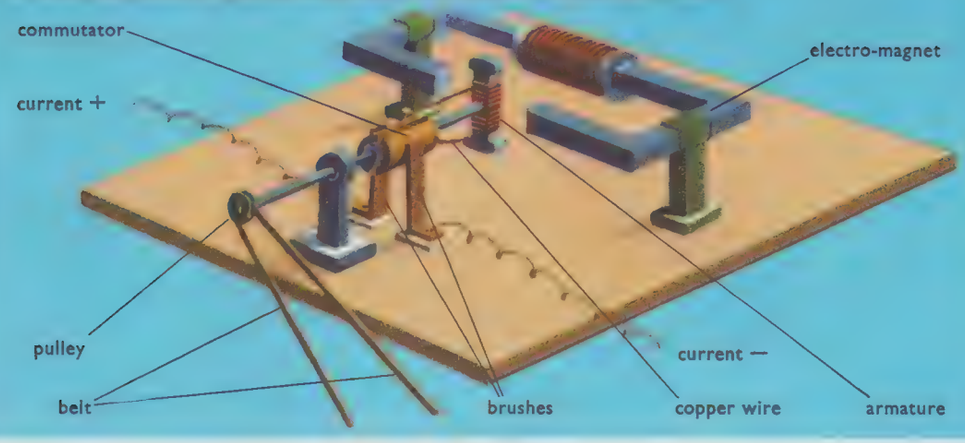
The principle applied in the dynamo: the petrol engine produces mechanical energy, turned to electricity by the dynamo (right)



The principle in reverse: the battery (left) supplies electrical energy to the electric motor, which results in mechanical energy

A few of the very many everyday items of equipment that work by means of an electric motor

SIMPLE MODEL OF A DYNAMO – MOTOR



This apparatus can effectively function as a dynamo or as a motor. If we make the armature revolve by means of the pulley, it will produce electric current which we can pick up through the commutator and the carbon blocks known as brushes; the machine is functioning as a dynamo. If we pass a current through the brushes and through the commutator, the armature will revolve and we shall be able to collect mechanical energy through the pulley. The apparatus has functioned as a motor.

The same as the dynamo

We have already seen what parts make up a dynamo; we will now look at these parts in rather more detail. First there is the powerful electro-magnet; we know that a very strong magnetic field is formed between its two poles. We call one pole the North pole and the other the South pole. Between the two poles, just where the magnetic field is strongest, we have placed the armature. The simplest form of armature is formed by a single coil of insulated copper wire which is wound round an iron core.

In the dynamo, as we have seen, the armature was made to revolve rapidly between the two poles by mechanical energy, and in this way was charged with electricity, which we took out as an electric current. In the electric motor, on the other hand, we introduce the current into the armature, and as a result of this it will begin to revolve. The revolving shaft connects with the pulley, through which we collect mechanical energy. The dynamo has become a motor.

Now let us see why the armature revolves when we pass an electric current through it.

The donkey and the carrot

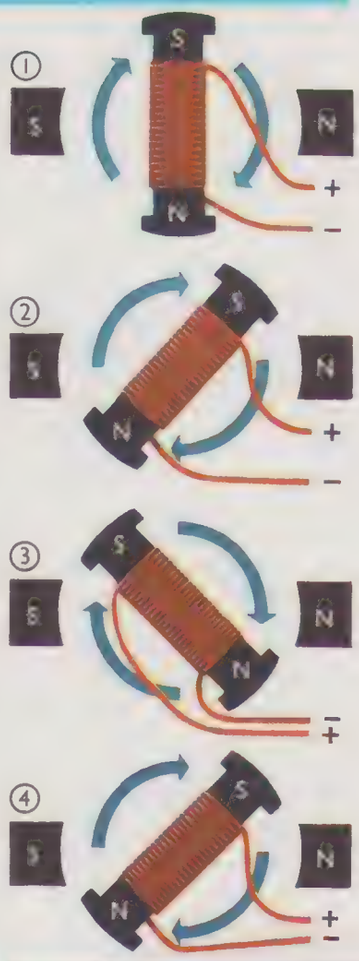
Most of us know the story of the donkey and the carrot. A man who had a lazy donkey tied a carrot on the end of a pole, climbed on to the animal's back, and dangled the carrot in front of its nose. The donkey, who was greedy, took a step forward in order to seize the carrot which, of course, moved forward as he did. The donkey moved faster and faster in pursuit of the carrot, which always remained just out of his reach.

This story seems completely out of place in a description of the working of the electric motor, but in fact a rather similar principle is used in making the armature revolve. The armature itself plays the part of the donkey, while the role of the carrot is played by magnetic attraction.

This is how magnetic attraction makes the armature revolve:

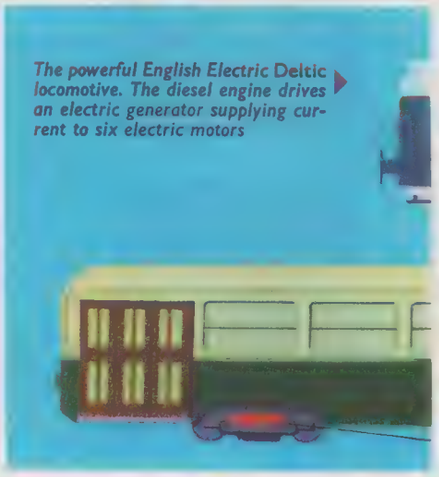
1. The armature has been placed between the two poles of the field magnet. We know that opposite poles attract and similar poles repel. This causes the armature to revolve in the direction indicated by the arrows in the illustration.
2. Each one of the two poles of the armature is on the point of reaching the pole of the magnet of the opposite polarity.
3. As soon as it has reached and, by force of inertia, slightly passed the pole, we change the direction of the current in the coil of the armature; the poles of the armature are then reversed. This means that similar poles are now together; they repel each other while the opposite ones attract, so the armature continues to turn.
4. In this way the armature continues to revolve, as the poles at either end of it constantly move towards their opposite poles on the magnet, and away from similar poles.

At this point a practical difficulty arises. How can the direction of the current be changed rapidly and frequently in the coil of the armature? To do this, one end of the coil must be in contact alternately with the positive wire of the electricity supply line, and with the negative wire. At the same

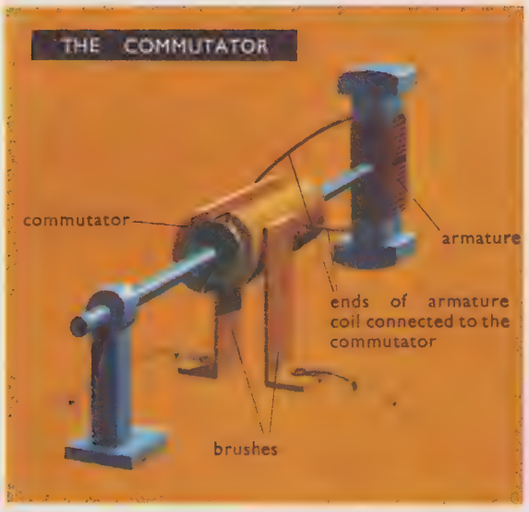


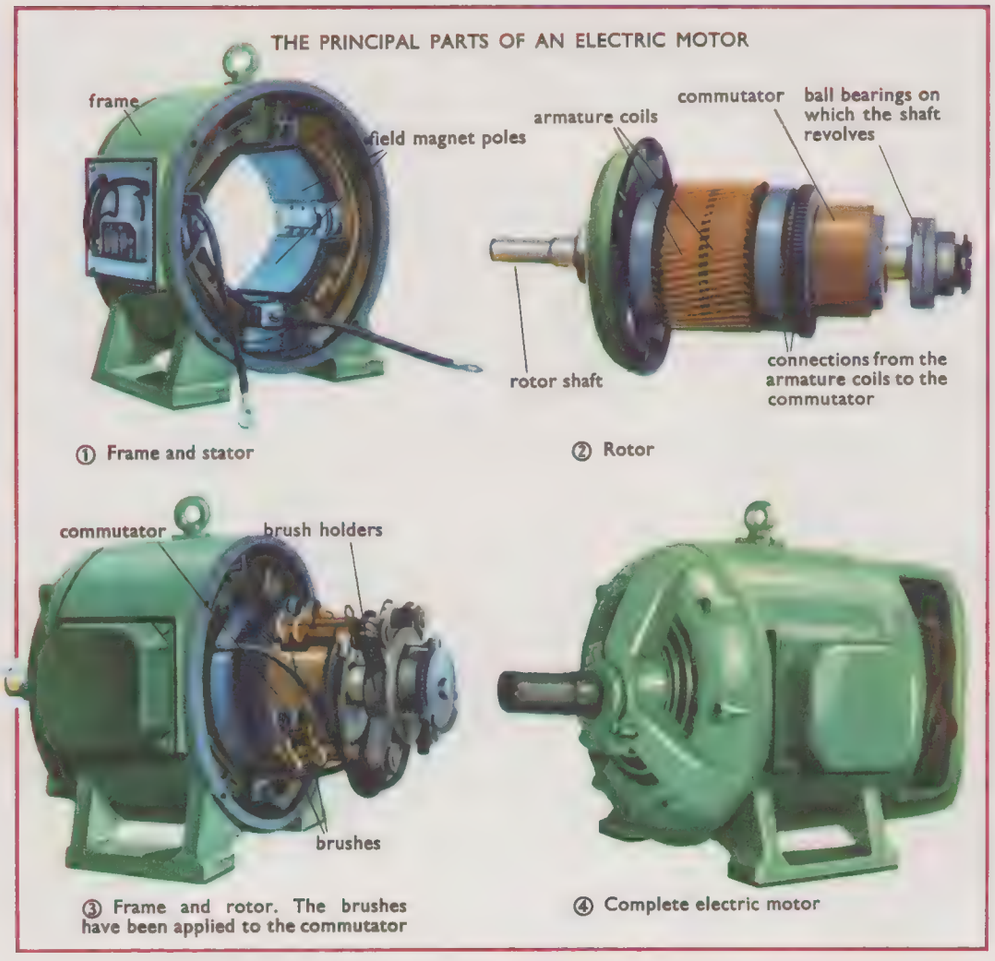
A PRINCIPLE

Every electro-magnet (like our armature) has two poles which we call North and South. By reversing the direction of the current the two poles are also reversed



The powerful English Electric Deltic locomotive. The diesel engine drives an electric generator supplying current to six electric motors



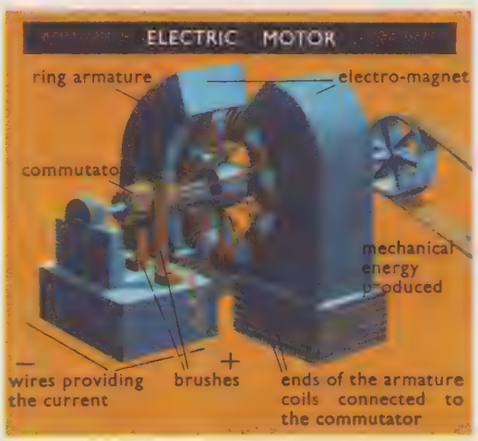


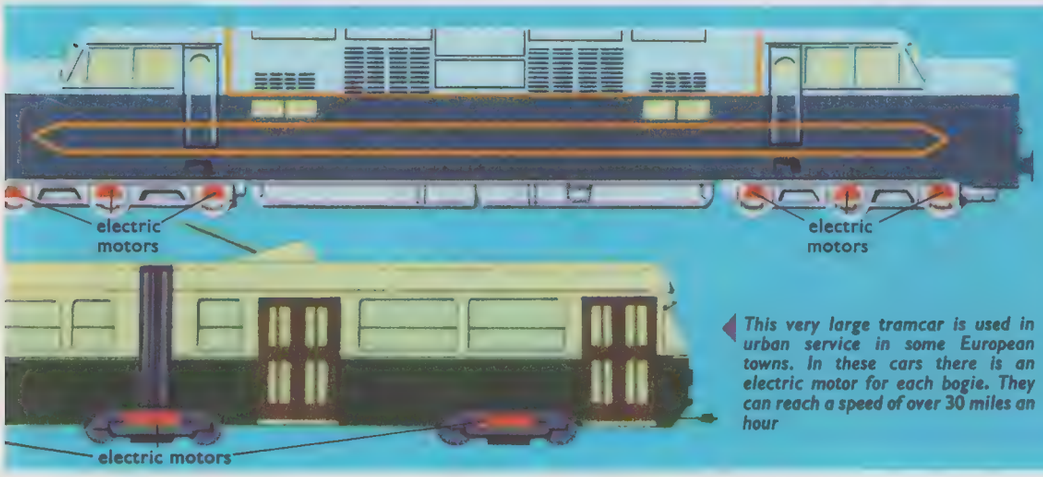
time it is essential that contact with the other end of the coil is established by the oppositely charged wire.

The commutator

The solution to this problem is very simple and ingenious. Two well-insulated metal half-cylinders are fixed to the armature shaft. To each one of these is connected one end of the coil of the armature. It is obvious that when they revolve these two half-cylinders come in contact first with one carbon brush, and then with the other, and as a result each one receives alternately positive and negative current. In this way the direction of the current in the coil is changing continuously. This important part of the electric motor is called the *commutator*.

But we can see that a motor as simple as the one drawn in our diagrams would function in fits and starts, with sudden bursts when the poles are near and the attraction is strong, and very brief pauses at the 'dead points', just like a car that has only one or two cylinders. In order to smooth out its movements, the number of poles in the armature is multiplied so that the thrusts and attractions follow one after the other as closely as possible. The armature is made in the shape of a ring, along which are distributed several coils. Naturally the coils placed at two opposite points are connected together, and the two ends of the wire terminate on two small metal plates (also opposite each other) on the commutator. This part of the apparatus has also been modified; the half-cylinders are no longer the only parts that pick up the current from the two brushes, but there are as many plates as there are coils on the ring. Assembled in this way, the electric motor has a quiet, powerful movement, and offers all those advantages which we mentioned earlier.





This very large tramcar is used in urban service in some European towns. In these cars there is an electric motor for each bogie. They can reach a speed of over 30 miles an hour

Now that we know how it is made, we can appreciate better the extreme simplicity of the electric motor. It has only one moving part – the ball bearings which allow the armature to turn on the shaft; only one point of friction – the very slight one of the two brushes on the commutator. Just compare this with all the levers, gears, pistons, and valves which make up a petrol engine!

In the electric motor it is only magnetic forces which are at work, and these cannot themselves wear out moving parts.

PARAGUAY

A native woman with her child

PARAGUAY TODAY

Paraguay has a total area of 157,047 square miles, and a rapidly expanding population of nearly 2 million. It is a democracy with two main political parties: the Nationalists and the Liberals. Communism is forbidden. The President, Nationalist army officer General Alfredo Stroessner, was re-elected for a period of five years in February 1963.

TO arrive in Paraguay is to step back in time. Many of the advances of the 20th century have by-passed this little South American state. In their land of flaming red trees, cobbled streets, broad rivers, and dense clouds of gorgeous butterflies, the Paraguayans live much as they did hundreds of years ago; illiteracy is high; a European woman may be stoned if she wears slacks; appointments are cancelled if it rains; 'office hours' (for the few people with office jobs) are from 8 a m to 11 a m.

The affairs of Paraguay have rarely troubled the rest of the world – nor have the affairs of the rest of the world troubled Paraguayans. Today the Paraguayan is much more aware of the political situation in Buenos Aires, capital of neighbouring Argentina, than in Moscow and New York.

There are, however, even in this remote wilderness, signs of progress. The occasional office block rises out of a street of picturesque old Spanish buildings. The occasional American may be seen fruitlessly prospecting for oil. But by and large the happy, good-natured Paraguayans have not been introduced to modernity, and nor do they show any inclination to be.

Paraguay has no coastline. Its southern boundaries are the rivers Pilcomayo and Parana, which divide it from Argentina. Its other boundaries, with Bolivia and Brazil, are less naturally determined, and indeed border disputes have occurred throughout its history.

To Europeans most of Paraguay is not a pleasant country. Much of the land area is taken up by the *Gran Chaco*, an inhospitable region lying to the west of the great river Paraguay. Some people call the Chaco the 'green hell'. It is flat and forested, with soggy soil, and its climate is hot, with summer temperatures well over 100°F. In winter this temperature is still a

A view of the vast plain of the Gran Chaco

steamy, unhealthy 75°F. Rainfall, though averaging a reasonable 32 inches a year, often falls in drenching cloud-bursts. Hordes of insects make life a misery, while huge, bulbous, cactus-like plants give the Chaco a nightmarish quality.

The Chaco merges into hot savannah land as it nears the Paraguay river. East of this river is a range of mountain land which is equally inhospitable. In fact, it is only in the south, in the fork between the rivers Paraguay and Parana, that conditions are at all bearable. And here it is wonderful. Paraguay's climate, where it is good, is very very good, though where it is bad it is torrid. The climate of the favoured south, extending as far north as the capital, Asuncion (population 300,000), has been described as a 'perpetual spring'. It is warm all the year round, and its 52 inches of rain make for a fertile, productive soil. It is in this region, and in some places along the Paraguay like Concepcion (population 80,000), that most of the people live.

One of the launches which journey up and down Paraguay's rivers

The people

There is a lot of mixed blood in Paraguay, which has been called the most 'colonised' country in the world. It has been settled by Poles, Swedes, Germans, Bulgarians, and Japanese. They have come for a variety of reasons; some came to escape religious persecution or to escape political tyranny. Many came simply because they were 'on the run' from the law. Whatever the reason for their arrival, these settlers have intermarried and merged with the resident population with astonishing rapidity – with one exception. This exception is the Mennonite colonies (two in the Chaco, and one east of the Paraguay). These colonies are German-speaking, and of Russo-German origin. They are pacifists and live in their isolated communities with no attempt to mix with the rest of the inhabitants.

But the first settlers were, of course, the Spaniards, who arrived in the 16th century. Paraguay today, like most of South America, shows its Spanish background clearly. Its religion is Roman Catholic and its language partly Spanish. Cities like Asuncion have many beautiful old Spanish buildings and the population is an indistinguishable mixture of Indo-Spaniards. But unlike most of South America, Paraguay was populated by tough, independent Indians who were never dominated by the Spaniards. These Indians belonged to many tribes, but shared the common *guarani* language. They are called guaranis, and their language, with the addition of many Spanish words, is today the main language of Paraguay – the other language is Spanish.

History

The first European to reach Paraguay was probably a Spaniard called Garcia, who was killed during explorations there in about 1520. Reports of his expedition reached Spain and, after explorations by Sebastian Cabot in 1526 and 1529, settlers arrived there. In the mid-16th century Franciscan and Jesuit missions arrived to attempt to convert the Indians. These early expeditions were not a success, and it was the progress made by a second band of Jesuits who arrived in 1608 that formed the basis of modern Paraguay. They established a 'Jesuit Empire' in what is now the south and east of Paraguay and introduced schools, hospitals, and, of course, the Roman Catholic religion. For about 150 years the history of Paraguay is in fact the history of the Jesuit missions in this area. Paraguay was not an independent country but still under the government of Spain. When, in 1750, Spain wanted to transfer part of the 'Jesuit territory' to Portugal as part of an exchange deal, the Jesuits fought bitterly against the transfer until their expulsion by the Spaniards and Portuguese in 1767.

The Jesuits had been popular. But more than this they had provided the foundation of the Paraguayan state. In 1811 the people of this area resisted the movement of other South American states to expel Spanish authority. The resistance was unsuccessful and the Spaniards were expelled. However, the Paraguayans set up a government of their own and in 1814 came under the rule of one of the most fascinating figures of Latin American history.

This first leader was the dictator Jose Gaspar Francia, 'El Supremo'. This sinister man dominated Paraguay until he was seized with a fit and died in 1840. He was a ferocious man who punished cruelly any attempt to curb his authority. But by his policy of complete isolation and his violent opposition to foreign infiltration he secured Paraguayan independence at a time when her incorporation into her monster neighbours, Argentina and Brazil, seemed certain.

Paraguay was involved in almost perpetual border disputes with Argentina and Brazil. Carlos Lopez, who succeeded Francia, continued a policy of isolation, but his son and successor, Francisco Lopez, involved Paraguay in one of the most disastrous wars any country has ever fought. In 1865 he used the occasion of a Brazilian intervention in a Uruguayan civil war to attack his enemy Brazil. Soon he was faced with a hostile coalition of Uruguay, Brazil, and Argentina. The war raged for five years. The Paraguayans fought with fanatical bravery. Children of 12 were sent into the front line. But by 1870, when Lopez died, their army had been utterly decimated. Before the war the population of Paraguay had been over a million and a quarter. *Four-fifths* of them died in the war, and in 1870 the male population of Paraguay, an area three times the size of England and Wales, was 28,000 – an average gate for an English football match! Ever since then most of the work has been done by women. Paraguay lost territory to both Argentina and Brazil and has never recovered from a war which her people speak of as if it happened yesterday.

Paraguay's second war, the Chaco War, against Bolivia in 1932–1935, ended more successfully. She enlarged her territories in the direction of Brazil and added greatly to her prestige.

Economy

Three products of Paraguay are unique: *yerba mate*, the famous Paraguayan tea; oil of *petitgrain*, a perfume base made by boiling bitter orange leaves; and *cana*, a rum fermented from sugar cane, and a favourite of South American cattlemen. High-quality limestone seems to be Paraguay's only mineral wealth. With it the Paraguayans, helped by Belgians, have built up a prosperous cement industry.

A scribe of the time of Assurbanipal working painstakingly on his tablets. These wonderful records have given us a detailed knowledge of the period

THE main reason for Assurbanipal's fame is that we know a lot about him. He may not have been the greatest of Assyrian kings, but chance has preserved for us no less than two great libraries in the Assyrian city of Nineveh. The 'books' of these libraries are nothing like modern books, but are tablets of baked clay, and the writing is in the cuneiform script (so called because the letters look like wedges, and *cuneus* is the Latin for a wedge). The thousands of tablets which survive from Assurbanipal's libraries tell us not only about the events of his reign (669–626 B C), but also about the everyday life of the ordinary people of Nineveh, their religion, and their literature.

A nation of warriors

The Assyrian empire which conquered so many surrounding nations began in the basin of the river Tigris. There was little geographical advantage to be gained from the situation, and the Assyrians owed their greatness to their unity as a nation and to their excellent army. While other nations were still organised as tribes, the Assyrians, with their well-trained soldiers, were able to defeat untrained forces many times larger than themselves.

Assurbanipal was the third son of King Esarhaddon, and he was not the heir to the throne. His younger twin brother, Shamash-shumukin, was at first expected to succeed, but there was bitter rivalry between the brothers, and Assurbanipal received the support of many influential courtiers. Assurbanipal was made king, while his brother became ruler of Babylon.

A reign of conquest

Assurbanipal inherited a war with the rebellious Eygptians from his father. Although he managed to crush this revolt he never succeeded in gaining complete control, and after about 20 years Egypt became entirely independent. Assurbanipal soon had another revolt on his hands. In 652 his brother Shamash-shumukin revolted after allying himself with various neighbouring rulers of Arabia and Elam. The King acted quickly, and within four years his brother was dead and Babylon captured. Assurbanipal now turned his attention to the Arabians and Elamites, who had helped his brother, and defeated them. Here is the King's own account of the victory, taken from one of the tablets: 'During one month and 25 days of marching, I devastated the provinces of Elam. There I spread salt and thorns, laying waste the land. The sons of the king, the sisters of the king, the members of the royal family of Elam, young and old, prefects, governors, knights, craftsmen, as many as there were of them, adults and children, horses and mules, donkeys, flocks and herds more numerous than a swarm of locusts, I carried off as spoils into Syria.'

A man of learning and culture

In spite of the many campaigns in which he was engaged, Assurbanipal found time to devote to literature and learning. He was responsible for the detailed researches carried on by the Assyrian scholars into the antiquities of Babylonia, which have recorded many valuable details for us. He collected the large library of tablets which were all carefully catalogued and classified. They contained historical records, astrological observations, oracles, prayers, hymns, and legends of man's early history, such as stories of the Flood bearing a great resemblance to the Old Testament story. The King himself enjoyed reading and discussion with the scholar-priests who ran the library. We read the words of the King himself: 'I learned the mysteries of the treasured art of writing on tablets. I understand the omens on the sky and on the earth. I argue in the meanings of the learned. I know how to work out difficult examples of division and multiplication. I know how to read the texts written in the difficult Sumerian language. I examined the stones written at the time of the universal deluge.'

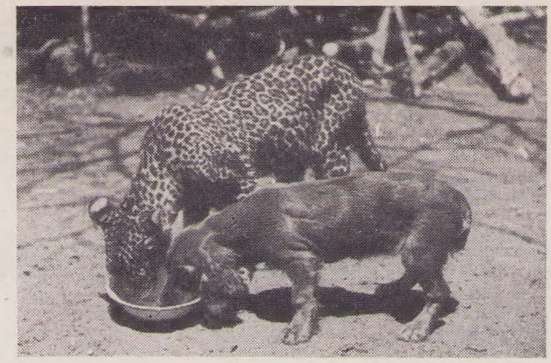
A sad ending

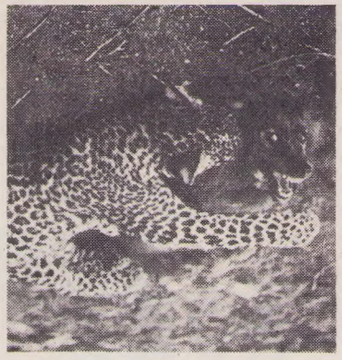
At the end of his reign, when all his enemies had been subdued, the King was able to divide his time between scholarly pursuits and more active sports like hunting and archery. He might have been expected to be a happy man. Yet at the end of his successful life, when he was perhaps ill, and worried by the problems of choosing his successor, we find him writing one of the most personal documents among the tablets: 'I did well to gods and man, to dead and living. Why have sickness, ill-health, misery, and misfortune befallen me? I cannot endure the strife in my country and the quarrels among my family. Misery of mind and body bow me down; with cries of woe I bring my life to an end. On the day of the festival of the city god I am wretched; death is seizing hold of me and bears me down.'

A SHORT-LIVED EMPIRE

By the time of his death in 626, Assurbanipal had established peace in Palestine, Phoenicia, and Syria, as well as crushing Elam and Arabia. Yet within a few years of his death the empire which he had built had collapsed. To begin with, there was fighting among his sons over the succession. The province of Babylonia revolted and in 625 became once more a separate kingdom. Finally in 612 the city of Nineveh was captured by the Babylonians and their allies, and in the words of the chronicle: 'they carried off the booty of the city, a quantity beyond reckoning, they turned the city into ruined mounds'.

DOG bites





LEOPARD – and gets away with it!

THE leopard has the reputation of being the fiercest and most vicious of the cat family. Among its favourite prey are dogs. Dogs have been known to become so terrified in the presence of leopards that they have lost their ability to bark.

However, the leopard and the dog which you see in the picture are a great exception to this rule. Betsy, the cocker spaniel, discovered her leopard friend when it was a baby in the Tanganyikan jungle. Since that time the spaniel and the leopard have grown up together. They play together, stroll through the jungle together, share the same water bowl and bed.

Of the two, the spaniel is by far the more energetic. The leopard likes to laze in the sun, and Betsy often has to nip its tail before it will arouse itself sufficiently to prowl along the forest paths.

But the leopard has never harmed the spaniel – not even by accident. During their playful fights the leopard's formidable armoury of vicious claws and sabre-like teeth has never been used to injure Betsy.

DID YOU KNOW? . . .

In London the central meat market is called Smithfield, originally 'smooth field'. In Norman times gorgeous pageants and tournaments were held on this open space, which, in the 12th century, became the scene of fairs and horse-markets. From 1135 to 1855, on August 24th Bartholomew's Fair was held at Smithfield. For many years a gibbet stood on this site, which was used both for duels and executions.

* * * * * * * * *

Grotius was reputed to be able to remember everything he had ever read. An actor called Cooke undertook to memorise the whole of a newspaper in eight hours. Louisa West, an American girl, learned the entire New Testament in 6 weeks, while doing her housework. Thomas Fuller, after a single walk between Cheapside and Temple Bar (in London), repeated accurately and in order every door sign on both sides of the road. Bishop Jewell could hear anything read once, and then repeat it forwards or backwards, from any point.

* * * * * * * * *

The new £450,000 radio telescope at Cambridge will enable British scientists to see 'almost to the edge of the universe', and record events happening more than 7,000 million years ago. The telescope, a 'trio of saucer-shaped aerials which are equivalent to a Jodrell Bank "dish" one mile wide', will be used to gather fresh facts about the birth of the universe. It is sensitive enough to identify a halfpenny at 100 yards.

* * * * * * * * *

The Englishman's umbrella was formerly an emblem of rank in the East, used only by royalty as a protection against the sun. In ancient sculptures Alexander the Great is shown beneath an umbrella. In Morocco only the sovereign, his sons and brothers used umbrellas. The first *ombrello*, or 'little shade', came to England by way of Italy and caused 'a proper commotion' when displayed at Bristol in 1780. Glazed cotton umbrellas were first manufactured in Scotland in 1783. In 1874 the sacred umbrella of Koffee Kalcalli, King of the Ashanti, was captured and taken to the South Kensington Museum.

* * * * * * * * *

100 years ago this year, Henry Ford, founder of the famous car firm, was born. When he died, 83 years later, his firm had built 30,000,000 cars. Ford did more than anyone else to bring cheap motoring to the public. Between 1908 and 1927, 15,000,000 of his famous Model Ts went off the production line. This austere, high-backed and reliable little vehicle was the most popular car ever made. Ford was reluctant to add gadgets to his cars or have any colour but black. The result was that many of his rivals, like Chevrolet, got a foothold in the small-car market. But though he may have been conservative in marketing his cars, Ford used brilliant and advanced production techniques. These techniques enabled him to bring out a mass-produced medium-sized car ahead of his rivals. This was the V8. Ford also gave Britain one of her most popular small cars – the Ford Prefect.

ARMAND DENIS MAY BE VISITING YOUR TOWN

Don't miss these exciting lectures about wild life, and primitive peoples. Tickets can be obtained from your usual suppliers.

Town	Hall	Date	Time
CARDIFF	Sophia Gardens Pavilion	Thursday, 22nd August	7.30 pm
BIRMINGHAM	Town Hall	Friday, 30th August	7.30 pm
WOLVERHAMPTON	Wulfrun Hall	Saturday, 31st August	3 & 6 pm
LONDON	Festival Hall	Sunday, 1st September	3 & 7.30 pm
NEWCASTLE	City Hall	Monday, 2nd September	7.30 pm
GLASGOW	Concert Hall	Tuesday, 3rd September	7.30 pm
ABERDEEN	Music Hall	Wednesday, 4th September	7.30 pm
LIVERPOOL	Philharmonic Hall	Thursday, 5th September	7.30 pm
BRIGHTON	Dome Theatre	Saturday, 7th September	7.30 pm
NORWICH	Theatre Royal	Monday, 9th September	7.30 pm
BRISTOL	Colston Hall	Tuesday, 10th September	7.30 pm
MANCHESTER	Belle Vue	Wednesday, 11th September	7.30 pm
SOUTHAMPTON	Guild Hall	Thursday, 12th September	7.30 pm
DUBLIN	Full details from Dublin Zoo; Friday, 13th September		

Announcement for readers of Yellow Knowledge

VOLUME XI TABLE OF CONTENTS

There are two corrections for this Table of Contents. Please cut them out and stick them on to your Table of Contents, under the section headings indicated:

GEOGRAPHY: THE WORLD – **add**
Climatic Zones 2097–2099

MATHEMATICS – **replace** 'Graphs' by
Number Patterns 2108–2109

Announcement for readers of Yellow Knowledge

Standard Binder for Volume 8

Easibinder for Volumes 7 & 8

AVAILABLE NOW!

The standard binder for Volume 8 is available now. The Easibinder for Volumes 7 and 8 is also still available. See your newsagent right away, or, in case of difficulty, write to Department B, 'Knowledge', 37 Hertford Street, London, W.1.

The standard binder costs 3s. 6d. and the Easibinder 13s. 6d. There is a 1s. 3d. charge for postage and packing from Department B, but more than one binder can be ordered for the same charge.

Remember – copies are better in a binder.

This issue contains the index for Volume 7.

You write – thousands read!

Indian Caves

DEAR EDITOR—The Ellora Caves are rock-cut temples, like the Ajanta Caves I told you about in my last letter (published in *Knowledge News* dated 7th July). Altogether there are 34 caves in this group, excavated from the face of a hill.

The 12 Buddhist caves are said to have been excavated between A D 350 and A D 700. The *Mahar Wada* is 117 feet long and 58 feet wide, and the roof is supported by 24 pillars. There used to be a monastery in the three-storeyed *Don Thal* cave.

The Brahmanical caves, 17 in all, were carved during the 8th to 10th centuries. The most beautiful is the *Kailash*, 164 feet long, 109 feet broad and 96 feet high, decorated with sculptures and carvings.

From the 10th to 12th centuries the Jain caves were cut from the rock.

I hope these letters will create some interest in Indian archaeology.

Deepak Merchant (*age* 15),
Sydenham College,
B Road, Churchgate,
Bombay 1, *India*.

A SHORT STORY

DEAR EDITOR—I would like to tell you the story of the man who tried to please everybody.

A man decided to sell his donkey, and so he started out early one morning with his son on his way to the market. The father rode on the donkey and the boy walked by his side.

They had not gone far when they met three men who greeted them and passed on their way. 'This is a strange kind of father,' said one. 'He shouldn't ride the donkey and make the poor little boy walk over this rough road. He ought to walk and let his son ride.'

Hearing this, the father got down from the donkey. 'You ride, I'll walk,' he said.

They had not gone much farther when two women came along. 'Look at that,' one of them said. 'That is just like the younger generation nowadays. They are completely selfish. Look at that big strong boy riding while his poor old father has to walk. He ought to be ashamed of himself.'

Both walk

The boy and his father heard what was said. 'What shall we do?' they said. 'It seems difficult to please people. Perhaps we had both better walk.'

So they walked on either side of the donkey. Soon they met some more people. 'Look at that couple of fools,' said one. 'They have got no more sense than to walk when they could ride. That donkey could carry both of them.'

Both ride

Hearing this, the son got up on the donkey with his father behind him, and the donkey trotted off briskly.

Then they met an old man. 'You ought to be ashamed of yourselves,' he called out to them. 'Two big strong men riding on a poor little donkey, you'll break its back.'

At this they got off and sat down in the shade of a tree and the donkey grazed along the side of the road while they considered how to get the donkey to town.

'I don't know what we are going to do,' the father said. 'It is not far to the market now, only another few miles. But I do not see how we are going to get the donkey there. If I ride, it is wrong. If you ride, it is wrong. People grumble if neither of us rides it, and if both of us ride it they shout at us. What are we going to do?'

They sat in silence for a while. 'I know what we will do,' the son said at last. 'We shall have to carry the donkey to the market. That should please everyone.'

Donkey on their heads

'That's a good idea,' said the father, 'let's do that.' They struggled to get the donkey on their heads and carried him to the market that way.

As soon as they came in sight of the market, people shouted with laughter.

'Look at these two fools!' they shouted. 'Did you ever see the like of this? Two men carrying their donkey to market instead of letting it carry them.'

The father and son lowered their donkey to the ground.

'Well, son,' the father said sadly, 'we tried to please everyone, but we've pleased no one. The best plan is to do what we think right in the future and take no notice of what people say. You cannot please everybody.'

Arbeed Durgauhee,
Surinam, Souillac,
Mauritius.

To sum up: you can please some people some of the time – but not all people all of the time.—Editor.

Unhappy Ending

DEAR EDITOR—We are always told not to end a sentence with a preposition. Here is an outstanding example of what not to do.

Mother says to her little boy, 'What did you choose this book to be read to out of for?'

Helen Ratcliff (*age* 10),
42 *Winchelsea Avenue*,
Bexleyheath, Kent.

Can you answer these?

Divide the three words of each group into two parts; then put the resulting six parts together to make three different words:

1. CARPET; RAILWAY; SHOP-DOOR.
2. BATTEN; BYWORD; FOREMAN.
3. PARKED; DECANT; ROTTEN.

Give the next two terms in the series:

4. 1, 3, 7, 15, 31, —, —.
5. 50, 60, 45, 70, 40, —,—.
6. $1\frac{2}{3}$; $4\frac{5}{6}$; —; —.

Replace the symbols by letters. Each symbol stands for the same letter *in its own sentence*.

7. H●✱ ✱●LES ✱R●✱ U✱ ✱●RCHES.
8. I ✱●ϕ- ● ✱-●ϕY ✱●ϕ-RS●CK.

Fill the gaps so that different words appear across and down in these word squares; do not use the same letter to fill the two gaps in each example:

9. DE– EVE –AD
10. –AT ORE AT–
11. WON –WE Y–W

ANSWERS

1. *RAIL-CAR; PET-SHOP; DOORWAY.*
2. *BATMAN; FOREWORD; TENBY.*
3. *PARROT; DECKER; TENANT.*
4. 63; 127 (*double each number and add 1*).
5. 80; 35 (*even numbers go up by 10, odd ones down by 5*).
6. $7\frac{1}{3}$; $10\frac{11}{12}$.
7. *HOP POLES PROP UP PORCHES.*
8. *I HAVE A HEAVY HAVERSACK.*
9. *DEN EVE WAD* 10. *BAT ORE ATE* 11. *WON AWE YEW*

(*WEY – river in Surrey – is possible in* 11.)

BRAIN ? BOX

1. Many English surnames arose from occupations followed by those to whom they were first given many centuries ago. Such were: Barker; Baxter; Chaucer; Fletcher; Furmage; Lister; and Lorimer. Can you say from what occupations these names come?
2. Frank had just arrived home from the school sports and was telling his father how he had run in the half-mile.

   'I can't understand it, Dad,' he said. 'We ran the first lap in lanes, just like the 440 yards, but for the second lap we were allowed to cut in and all run in lane one. Surely it would have been much better for everyone to have kept to the lanes for the whole race.'

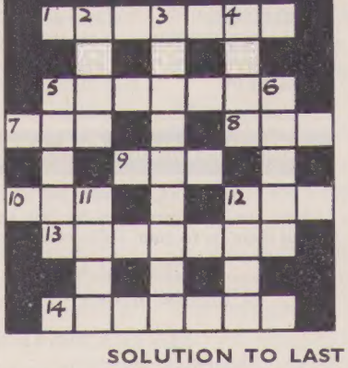
   Would it?
3. ACT; FOIL; MARCH; PANE; POINT; SIGN.

   Can you find a 2-syllable word to put before each of these words to make new ones?

ANSWERS

1. *Tanning; making bread (feminine of Baker); making shoes; making arrows; cheese-making; dyeing; making spurs.*
2. *No. If the first lap is run in 440-yard lanes, each runner has completed this distance when the lap is completed, and it would be impossible for the runners to begin the second lap at their staggered marks. Thus the second lap is run in the inside lane.*
3. COUNTER.

HIGH-SPEED CROSSWORD



Clues Across

1. Record of the past (7).
5. Agitated – like Christmas pudding? (7).
7. —— the Lion (3).
8. Lacking moisture (3).
9. Home for sheep (3).
10. Poetic form (3).
12. Little insect as industrious as 6 down is lazy (3).
13. Dickens' miser (7).
14. Slavery (7).

Clues Down

2. Preposition (4).
3. Fired upon (from a submarine most probably) (9).
4. Stalk to make a pipe (4).
5. Grains for future crop (5).
6. The lazy insect (5).
11. Return noise (4).
12. All eager (4).

Solution next week.

SOLUTION TO LAST WEEK'S CROSSWORD

ACROSS: 4, Rebates; 6, Wen; 7, Auk; 8, Gamp; 9, Bus; 11, Spy; 12, Moor; 13, Her; 14, Try; 15, Drought.

DOWN: 1, Hen; 2, Dangerous; 3, Teams; 4, Resumed; 5, Support; 10, Sorry; 14, The.

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The position of the mouth varies greatly in speech; this is what it looks like when someone is saying 'tea' (left) and 'taa' (right)

both the position and the tension of the vocal cords.

Speech

During quiet breathing the laryngeal muscles hold the arytenoid cartilages in such a way that the vocal cords are drawn towards the sides of the larynx. There is thus ample room for each breath to pass between the cords. When a sound is to be made, however, the muscles move the cartilages until the free edges of the vocal cords come together in the centre of the larynx. The breath passing from the lungs is thus impeded, and to escape it must first blow the vocal cords aside. This it does, vibrating the cords as it finds its way past them in a series of little puffs. These puffs form the air waves which reach our ears and which we recognise as sound.

The *loudness* of the sound made by the vocal cords depends on the size of the vibrations and the air puffs. If only a little air is used the vibrations of the cords are small and the sound made is a soft one. A loud shout requires a lot of air to make the cords vibrate violently, and this is why it is first necessary to take a deep breath.

The *pitch* of a voice sound – that is, its highness or lowness – depends on the weight, the length, and the tension of the cords. The high-pitched voices of women and children are made by cords about three-eighths of an inch long, but in males, at puberty, there is a rapid growth of the larynx and the cords increase in length to about half an inch. The greater weight and length of the cords in the adult male reduce the rate at which they can vibrate, and so the voice 'breaks', and becomes lower in pitch.

Now although the size of the vocal cords largely determines whether a voice shall sound like that of a child or woman, or of a man, it does not fix the pitch of a voice completely. Different people's voices, as we know, can vary considerably in

The tongue position varies with the vowels; the higher position is for 'mean', the lower for 'man'

pitch, and this is because the laryngeal muscles act on the cords and alter their tension. When drawn tight, the cords vibrate rapidly and produce a note of high pitch; when the cords are less tense, the note is lower.

Strangely enough, the sounds which are made in the larynx are not, in themselves, the sounds with which we are familiar in speech. There are two reasons for this. The first is that because the cords are small, the sounds they make are rather feeble. Fortunately the chest, the pharynx, the nose, and the mouth act as *resonators* for these small sounds, making them much louder. The second reason is that the sounds made by the cords are modified by the palate, the tongue, and the lips. These modifications are very important, for they greatly increase the number of sounds available for use in a language.

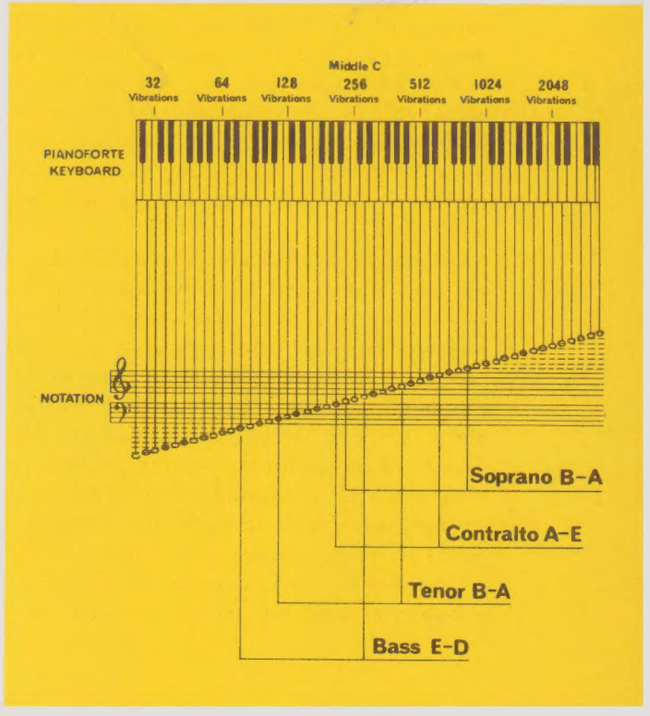
Phonetics

Phonetics is the science which deals with the sounds of words and the way in which these sounds are produced. Its name comes from the Greek *phonein*, to utter sound.

If you place a finger on your larynx again, and then say the sounds (not the names) of the letters in the alphabet, you will notice that the pronunciation of some of the sounds is accompanied by an easily felt vibrating sensation. This sensation is due to vibrations of the vocal cords as the letter sounds are *voiced*. You will notice, however, that when you make the sounds of f, k, h, p, s, t there are no vibrations. These sounds are *voiceless* ones. They are made in the mouth and do not involve the vocal cords.

The sounds made when the air passage through the mouth is unobstructed by either the tongue or the lips are called vowels. They are a, e, i, (y), o, and u, all of which can be pronounced loudly and continuously. The differences between them are

The comparative ranges of the human voice and of the piano. The usual range of a human voice is about two octaves



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Knowledge

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contents

Three very different voices of the 20th century: Sir Winston Churchill, politician; Billy Graham, high-powered preacher; and Elvis Presley, modern 'pop' singer

due to different positions of the lips and the tongue. If you look in a mirror and say the vowel sound of the word 'tea', the corners of the mouth will be seen to be drawn apart and in a position quite different from that used to say the vowel sound in 'taa'. Further, and a little more difficult to observe, when you say the vowel of 'mean' the tongue is much higher in the mouth than it is for the word 'man'.

In *written* English the six vowel letters are used singly and in combination for 21 vowel sounds in the *spoken* language. Frequently, however, the spelling of a word fails to give a true idea of the way it is pronounced, so to be accurate Phonetic Script needs a symbol for each of the 21 sounds. Many of these symbols are letters with which we are familiar, but others are strange, and it is these which give Phonetic Script its rather quaint appearance.

The sounds which are made when the air passage through the mouth is partly or completely closed are called *consonants*. Some are voiced, others are unvoiced, sounds. In English speech about 35 different consonants are used, and for each there is a special phonetic symbol. The consonants l, m, and n can be spoken continuously like vowels, but b, d, g, k, t, and p are little explosive sounds and can only be made momentarily. M and n are called *nasals* because they are made down the nose with the mouth closed. F, v, s, z, th, and sh are made by narrowing the outlet at the front of the mouth so that a friction sound is made as the air passes through. And the sound r, which many people find surprisingly difficult to pronounce, is made by tapping or rolling the tip of the tongue on the hard palate just behind the front teeth.

Song

In speech the vowels are pronounced quite briefly and the consonants sounded moderately. In singing the vowel sounds are held at a constant pitch for an appreciable time and the consonants need to be pronounced with extra force so that they can be clearly heard. In much serious music the vowels are held so long that the words are completely unintelligible. Pop music, on the other hand, almost always has vowel sounds which are shorter, and so the words are easily recognisable.

As in speech, the range, or *compass*, of a singing voice depends largely on the size of the vocal cords. The pitch of a particular note within that compass depends on the tension of the cords. The ranges of four familiar singing voices are shown in the diagram. By comparison with the range of the piano, the range of the human voice is quite small, being generally about two octaves. It is interesting to notice, however, that although the soprano voice sounds so different from that of the bass, the ranges of these two voices do, in fact, overlap. At the lower end of her compass a soprano can sing middle C, a note which can be sung also by a bass voice.

The note middle C is heard when the vocal cords vibrate 256 times each second. It would be reasonable, therefore, to expect the middle C of the soprano to sound exactly like that of the bass, but this is not so. The difference is due to the unequal resonance of the air passages of the two singers and to the presence of overtones caused by segments of the vocal cords vibrating independently of the whole. It is these factors which provide human voices with *timbre*, or tone quality, and consequently make them interesting and personal.

Yma Sumac, the Peruvian possessor of a fabulous four-octave voice

Some famous voices

Elvis Presley is the idol of millions of teenagers. His polished singing commends him to many people who would be called 'squares' by his teenage admirers.

Winston Churchill is an Englishman, American, historian, journalist, bricklayer, politician, and orator. His choice of words, his measured phrases, and his calculated mispronunciations inspired all the English-speaking people during the dark days of the Second World War.

Billy Graham, an American evangelist, must surely be one of the most persuasive speakers of all time. In 1954 he visited Britain, where he addressed vast crowds at Harringay Arena. The scenes of religious enthusiasm which he induced among his audiences were quite without precedent in Britain.

Yma Sumac was born a Peruvian, but is now an American citizen. This singer possesses a voice of an almost unbelievable compass – four octaves. She has made several remarkable recordings.